FINAL REPORT

RESEARCH ON HUMPBACK AND BLUE WHALES OFF CALIFORNIA, OREGON AND WASHINGTON IN 2002

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EXECUTIVE SUMMARY

Cascadia Research continued a long-term research effort on humpback and blue whales off California, Oregon, and Washington in 2002. The research had a number of components with the overall purpose to examine distribution, abundance, movements, and population dynamics of humpback and blue whales in the eastern North Pacific using photographic identification of individual animals. Also included in the effort in 2002 was monitoring underwater behavior and vocalizations of blue whales as part of a cooperative research effort with Scripps Institution of Oceanography, National Geographic and Office of Naval Research.

Identification photographs were taken from a number of platforms and collaborators. Cascadia Research conducted 89 days of effort totaling 798 hours and 6,352 nmi from small boats. Additional identifications photographs were obtained by: 1) SWFSC scientists during the outbound leg of a cruise headed off California, 2) by the naturalists from the Channel Islands National Marine Sanctuary's Whale Corps opportunistically as a part of whale-watching trips in the Santa Barbara Channel, 4) by Peggy Stapp and Nancy Black opportunistically from whale-watch boats in Monterey Bay, and 5) as part of some surveys conducted by the Olympic Coast National Marine Sanctuary off northern Washington. In total, suitable identification photographs of blue whales were made on 530 occasions representing 312 unique whales, one of our highest annual totals. Humpback whales were identified on 529 occasions representing 347 unique individuals.

Estimates of humpback whale abundance using a number of mark-recapture models revealed an increase in abundance of humpback whales from the past two years with 2001-2002 estimate of 1,034 (CV=0.11). This is an increase from the previous two estimates (1999-2001) that were under 800. Humpback whale abundance had steadily increased from the early to the late 1990s at a rate of about 9% per year. Some time between 1998 and 1999 there had been a drop of 25% in our estimates of abundance. Because our most recent abundance estimate represents a larger increase from previous years than would possible by population growth alone, it suggests either the drop in the late 1990s may not have been as large as originally estimated or the current estimate may be high due to chance or bias.

We were able to obtain a more accurate updated blue whale abundance estimate incorporating the 2002 data. The pooled sample from 2000 to 2002 of the systematic and coastal samples was adequate to estimate abundance with a similar level of confidence as in past years. Estimates for 2000-2002 for right and left sides were 1,567 (CV=0.32) and 1,953 (CV=0.33), respectively, averaging 1,760. This is slightly lower than estimates from 1991-93 and 1995-97 using similar procedures. While these estimates are not significantly different from those in the early and mid-1990s, they do not suggest that blue whale populations have been increasing over the last decade has was the case with humpback whales.

Tagging efforts in 2002 resulted in successful suction-cup attachment of three types of tags on blue whales (National Geographic's Crittercam, Bill Burgess's bio-probe acoustic tag, and WHOI's dTag). One extended deployment provided more than 15 hours of dive data through the evening and night. Underwater vocalizations by the tagged or adjacent animals were documented on three deployments (one of each tag type).

INTRODUCTION

This report summarizes the fieldwork conducted by Cascadia Research and collaborators in 2002 for humpback and blue whales off California, Oregon, and Washington. While the focus of this report is the results from the photographic identification research, we also summarize some of the findings from related work collecting skin samples and deploying tags on whales. The primary purpose of the photographic identification research has been to examine distribution, abundance, movements, and population dynamics of humpback and blue whales in the eastern North Pacific.

Principal support for this research was from Southwest Fisheries Science Center to assess population size and trends as well as reproductive and mortality rates (second year of work under Contract #50ABNF100065). Support for several related projects that allowed additional opportunities to obtain identification photographs and other types of data that came from several additional sources:

- Office of Naval Research provided support for some of the tag deployments including National Geographic's Crittercam, WHOI's dTag, and Burgess' acoustic tag on blue whales off California under grant award No. N00014-02-1-0849.

- Support for some of the work off Southern California was provided through a subcontract from Scripps Institute of Oceanography (Purchase Order 10200451) as part of a project on ambient noise and blue whale vocalizations for the San Clemente Offshore Range (SCOR) funded by SERDP.

- The National Marine Mammal Laboratory provided partial support for some of the gray whale work in Washington and Oregon under Purchase Order #40BANF112521.

- Support was received from the Olympic Coast National Marine Sanctuary for some of the survey work off northern Washington under Purchase Order 40-ABNC-112741.

- Support for some of the work off Oregon came through a subcontract from Oregon State University for work associated with the GLOBEC project.

- Michuru Ogino provided support for the vessel charter of a joint Cascadia/Department of Fisheries and Oceans cruise for humpback and blue whales off British Columbia.

- MCAF provided support for a collaborative research effort with the University of Aukland that involved obtaining biopsy samples from humpback whales off California, Oregon, Washington, and British Columbia

- Several private contributors provided support for conducting the research.

METHODS

Survey regions and coverage

Identification photographs in 2002 came from a number of sources and survey types including:

- Dedicated photographic identification surveys conducted by Cascadia Research off California, Oregon, and Washington (Table 1, Figure 1)
- Surveys conducted in central British Columbia waters as part of a 8-day expedition for humpback, blue, and gray whales based aboard the vessel *Curve of Time* (Table 2, Figure 2)
- Identification photographs taken by Cascadia Research off Oregon and California incidental to tag deployments (Table 1)
- Identification photographs taken by both Cascadia and sanctuary personnel off NOAA ships and boats directly associated with cruises conducted by the Olympic Coast National Marine Sanctuary off northern Washington (Table 3)
- Identification photographs taken by members of the Channel Island National Marine Sanctuary's Whale Corps incidental to whale watch trips in the Santa Barbara Channel (Table 4)
- Identification photographs taken by Peggy Stapp in Monterey Bay as a part of whale watch trips conducted by Nancy Black (Table 5)
- Identification photographs of blue whales obtained by SWFSC personnel as part of a cruise leaving San Diego for Hawaii
- Other opportunistic identification photographs obtained by Bernardo Alps and Michuro Ogino

Overall effort is summarized in Table 6. Cascadia conducted 89 days of effort off California, Oregon, and Washington (Table 7). Effort was broadly distributed geographically and temporally (Table 7, Figure 1). Survey coverage was most extensive in the Santa Barbara Channel, Monterey Bay, and Gulf of the Farallones. Effort was most extensive in these regions due to large concentrations of whales in these areas and the presence of opportunistic sources of effort. Effort in the both the Santa Barbara Channel and Monterey Bay included dedicated photo-ID coverage by Cascadia, photo-ID in conjunction with tagging efforts (see later), and opportunistic identifications from whale-watch vessels (CINMS Whale Corps in the Santa Barbara Channel and P. Stapp and N. Black of Monterey Whale Watch in Monterey Bay). This combined effort resulted in a fairly broad distribution of locations and months that both humpback and blue whale identifications were made (Tables 8-9, Figures 3-4)

Photographic identification methods

Identification photographs were taken with *Nikon* 35mm cameras (8008 and N90s) equipped with 300mm *Nikkor* telephoto lenses and databacks that recorded date/time on the exposed film. High-speed black-and-white film (*Ilford HP-5+*) was exposed pushed 1 stop so that exposure times were generally 1/1,000 or 1/2,000 sec.

Identification photographs of humpback and blue whales were taken using standard procedures employed in past research off California and Washington (Calambokidis *et al.* 1990a, 1990b, 1996, 2000, 2001b). Both the right and left sides of blue whales in the vicinity of the dorsal fin or hump were photographed as well as the ventral surface of the flukes. For humpback whales, photographs were taken of the ventral surface of the flukes.

Humpback and blue whale identification photographs taken in 2002 were compared internally and then to catalogs of all humpback and blue whales identified previously along the west coast. These catalogs consisted of 1,323 different humpback whales and 1,361 different blue whales identified during annual surveys between 1986 and 2001 off the west coast (Calambokidis *et al.* 2002). Additional identifications included in these collections are whales identified in other areas such as off Central America by Cascadia and collaborators (Rasmussen *et al.* 1999, 2000, Chandler *et al.* 1999). Individual whales identified in 2002 that did not match past years and were of suitable quality were assigned a new unique identification number and added to the catalogs.

Observations were routinely made of the feeding behavior of both humpback and blue whales. A variety of data are also recorded that are related to feeding including surface temperature, water depth, the presence and depths of any scattering layers, and bird species associated with sightings.

Mark-recapture estimates

Estimates of abundance were calculated using several mark-recapture models (Hammond 1986, Seber 1982). We used pairs of adjacent years from annual samples taken from 1991 to 2002 for California, Oregon, and Washington to generate Petersen mark-recapture estimates. The Chapman modification of the Petersen estimate (Seber 1982) was used because it was appropriate for sampling without replacement (Hammond 1986). Abundance estimates were also obtained using the Jolly-Seber multi-year models and annual samples. General assumptions and potential biases for these calculations are discussed in Hammond (1986) and Calambokidis *et al.* (1990a).

In addition to annual samples, we also conducted Petersen mark-recapture estimates using samples stratified by type of survey. To avoid heterogeneity of capture probability due to geographic sampling bias, we used the identifications obtained during systematic surveys conducted by SWFSC covering coastal and offshore waters of Baja California, California, Oregon, and Washington. Identifications from these surveys, although small, provided a sample that was not biased geographically. These systematic samples were paired with the larger but more geographically biased sample obtained during the more extensive coast-based surveys for the same 2 to 3-year periods.

A more conservative method for calculating the variance of Petersen capture-recapture estimates based on the jackknife procedure was employed here. Traditional estimates of variance from capture-recapture estimates may be biased downward because identifications are not independent events. Geographical clumping of animals often resulted in a concentration of sampling effort in these regions. Other aggregations of animals may have not been seen and not sampled.

Although humpback whales often range widely along the coast of California, Oregon, and Washington during the season, animals show a preference to return to similar areas each year. To incorporate the variance introduced by this geographic clumping of whales and sample effort, a jackknife estimate of variance was calculated using entire regions as samples. Each sample was divided into five to nine subsamples based on regions and time period. To obtain similar sample sizes, some adjacent regions were pooled together and some areas of high coverage divided into subsamples by season. For capture-recapture calculations that were based on multi-year samples taken from different platforms (SWFSC vs. other), each platform was divided into five roughly-equal subsamples based on year of sample and broad regions. Pseudovalues for generating the jackknife variance were calculated by excluding each sample from the estimate. Because the Petersen estimate is based on two samples, between 10 and 16 pseudovalues were calculated for each estimate.

Variance was calculated as:

$$VAR = \frac{(n-1)}{n} \sum (P - P_i)^2$$

from Efron (1982) where n is the number of estimates, P_i is each of the abundance estimates calculated by excluding one set of samples, and P is the abundance estimate using all data.

Collection of skin samples

A total of 111 skin samples were collected from whales in 2002 from a variety of locations and using a variety of methods (Tables 10-12). We had an expanded effort to obtain skin samples from humpback whales in 2002 as part of a collaborative research effort with Dr. Scott Baker. Off California, Oregon, and Washington 43 samples were obtained from humpback whales (all but one by biopsy) and an additional 23 collected off British Columbia in collaboration with Department of Fisheries and Oceans.

We continued to collect blue whale samples in association with tagging and acoustical monitoring of whales. Of 29 blue whales samples collected, 19 were sloughed skin primarily from the suction cup of tags during deployments off Monterey Bay or in the Southern California Bight.

We also obtained smaller numbers of skin samples from other species. We obtained skin samples from three fin whales that had been struck by ships and killed at sea and brought into Washington waters on the bows of ships. We also collected three samples from live fin whales near the Queen Charlotte Islands. Skin samples were obtained from a single gray whale in northern Puget Sound in 2002. Skin samples were obtained from three sperm whales, two from stranded animals in Washington State and one from a biopsy of an adult male off northern Vancouver Island. Three killer whales samples were obtained from one group in the Santa Barbara Channel.

Skin samples were collected to examine genetic relatedness, population structure, and sex of individual whales (Baker *et al*. 1990, 1998). Biopsy samples were collected from whales using the system developed by Lambertsen (1987). The biopsy system has three integral components: a biopsy dart and punch, a projection unit, and a retrieval system. The biopsy dart consists of a crossbow bolt (arrow) affixed with a stainless steel biopsy punch. The biopsy punch has a flange or 'stop' to prevent the shaft of the dart from penetrating of the skin. The punch is 7 to 9 mm in diameter and 2 to 5 cm in length and is fitted with two or three internal pins to secure the sample. A hole drilled transversely through the punch and just distal of the flange prevents pressure buildup inside the punch as it penetrates the skin. The projection unit is a commercially available crossbow fitted with a 125 or 150-lb draw fiberglass prod (bow). Sample extraction occurs with the recoil of the dart when the flange strikes the skin. We used an untethered free-floating bolt retrieved by hand from small vessels or with a dip net from larger vessels.

We collected blubber from biopsy samples (when available) for pregnancy testing (in collaboration with SWFSC). Blubber was separated from the skin with a clear razor and stored in a separate small vial and frozen after return to shore for submission to SWFSC.

Tagging

Tagging in 2002 consisted of deployment of three instrument packages on blue and humpback whales. All three were attached to the whale with a suction-cup and deployment was achieved by close approach and placement on the whale using a long pole to make direct contact with the whale. The three deployed tags were:

Crittercam: A package developed by National Geographic and termed “Crittercam” was deployed on blue whales (Marshall 1998, Williams *et al*. 2000, Francis *et al*. 2001). The instrument packages deployed contained a combination of the following instruments and devices:

- Hydrophone and recording system for underwater vocalizations
- Pressure sensor to record water depth
- Sensor to monitor and record water temperature
- Conductivity switch to control surface and underwater instrument activation
- VHF tag to provide local positioning information
- Underwater video camera to record behavior and prey

Burgess Bio-Probe: An acoustic tag deployed developed by Bill Burgess of Greeneridge Scientific Services (with support from ONR) an deployed as part of a collaboration with Scripps Institute of Oceanography. Joe Olson of Cetacean Research helped to test the tag and develop a delivery and attachment method for the tag. The tag recorded underwater sound and dive depth. The tag was potted in resin and was much smaller than in previous tag deployments. The tag sampled acoustics with 16-bit resolution at bandwidths up to 14 kHz, as well as temperature and depth with 12-bit resolution. Constant acoustic sampling at 2 kHz fills the 576-MB solid-state flash disk in 41 hours. Low-power three-volt electronics allow a single half-AA-cell lithium battery to power the entire tag.

WHOI (Woods Hole Oceanographic Institute) digital tag: The WHOI digital tag has been developed in recent years and successfully tested on a number of species. A graduate student at WHOI, Becky Woodward, collaborated with us in conducting deployments in the Santa Barbara Channel. The digital tag consists of:

- a hydrophone (acoustic) channel with a 12-bit analog-to-digital converter, and a programmable gain filter. The typical acoustic sampling rates are 16kHz or 32 kHz.
- additional sensors, sampled at 12 bits and roughly 23 Hz (when audio sampling is 16 kHz), including
- a pressure sensor to measure depth, 0-2000m, resolution of 0.5m.
- a thermistor both for water temperature and to correct the pressure sensor readings.
- 3-axis accelerometers to measure pitch and roll.
- 3-axis solid-state magnetometers to measure heading.
- a salt water switch to detect surfacings and to trigger the initial recording of data.
- depending on the tag version, from 400 megabytes to 1.6 gigabytes of flash memory to record up to 20 hours of acoustic and sensor data when sampling at 16 kHz. Lossless compression will be investigated.
- a nichrome wire release mechanism, which can be triggered to corrode away slowly and release the tag from the animal after a set amount of time. When the nichrome wire has corroded away, a small valve is opened, flooding the suction cups and allowing it to float to the surface.
- a VHF radio beacon to enable tracking and focal observations of the whale when it surfaces, and to find the tag for recovery when the suction cups release from the animal.
- a real-time clock to give an accurate time base and to trigger events such as the nichrome wire release.
- an infrared serial port for menu-based user interface and for data transfer. LEDs (active only before deployment) also provide the user with the tag state (armed for recording).
- a low-power digital signal processor capable of 100 million instructions per second, enabling complex compression and detection routines.
- a lithium ion polymer rechargeable battery pack, 2 Watt-Hours. Power consumption when recording is about 150 mW.

RESULTS AND DISCUSSION

Number and distribution of identification photographs

Dedicated and opportunistic surveys resulted in suitable identification photographs of blue whales on 530 occasions representing 312 unique whales (Table 8, Figure 3). Over half the blue whales identified in 2002 were photographed in the Santa Barbara Channel. These were spread out from May through November with largest numbers from June through September. Most of the whales were along the southern portion of the Santa Barbara Channel (Figure 3).

Identifications of humpback whales were made on 529 occasions representing 347 unique individuals (Table 9). Humpback whales were identified between February and November and covered a broad range of locations (Figure 4). Large number of identification photographs were obtained in the Santa Barbara Channel, off Pt Sal, in Monterey Bay, in the Gulf of the Farallones, off central Oregon, and off northern Washington.

The 312 blue whales identified in 2002 is the highest number of individuals we have identified in any year in our study eclipsing the previous maximum of 279 in 1992 (Table 13). The high overall numbers in 2002 were the result of the large number of whales identified in the Santa Barbara Channel. In no previous year have so many whales been identified in a single region. With the 2002 effort, 1,495 unique individual blue whales have been identified off California (Table 13).

The 347 identifications of humpback whales in 2002 was not a record (435 were identified in 1998) but was higher than 2000 or 2001 (Table 14). The humpback sample in 2002 was from a broader set of regions than most previous years. With the 2002 sample, the humpback whale catalog for California, Oregon, and Washington now totals 1,438 (Table 14).

Surveys off central British Columbia yielded sightings of a number of whale species including humpback, gray, fin, sperm, and killer whales (Figures 5-6). Humpback whales were the most frequently sighted large cetacean and were seen concentrated in a number of areas with highest densities west of Cape Scott and the Trinity Islands and near Cape Caution (Figure 5). Gray whales were seen along a stretch of northern Vancouver Island and around Cape Caution (Figure 6).

Sighting of humpback whale mothers and calves

In the 2002 surveys, thirteen individual humpback whales were identified as mothers with calves (including one tentative identification); six calves were identified photographically. Of the 317 individual humpback whales identified in 2002 (California-Washington not including the Wash/BC border and northward), 4.1% of these animals were identified mothers. This crude measure of reproductive rate is low compared to recent years (Table 15); over the last 10 years it has ranged between 2.4-8.0% (mean 5.2%, s.d.= 1.5). Reproductive rates estimated for humpback whales off California have been lower than those reported for other humpback whale populations (Steiger and Calambokidis 2000).

It was unusual that most of the mothers (10 of 13 or 77%) identified in 2002 were seen for the first time with calves, although most were not young females (7 of 10 first seen with calves were at least 10 years old). In comparison, 59% were animals identified for the first time as mothers in 2001.

Three of the whales identified as mothers in 2002 were seen in previous years as calves; they were 5 (11227), 11 (10538) and 14 (9503) years old. All three mothers were identified with their calves in the same location where they were photographed previously as calves.

Movement of humpback whales

Resightings of identified humpback whales seen multiple times in 2002 provided insight into movement patters (Figure 7). We documented frequent movements of animals among the various locations whales were seen off California. While within season movement of animals between Oregon and California was not common, two whales identified off Oregon in early September were resighted in late September and October off central California. There was no movement of animals documented in 2002 between northern Washington and other areas we identified whales.

Abundance estimates

Humpback whales

The abundance estimate for humpback whales using the 2001 and 2002 samples was 1,034 (CV=0.11 with jackknife procedure, Table 16). This is the highest estimate of humpback whale abundance we have obtained in our work and follows two years of dramatically reduced estimates of abundance (Table 16, Figure 8, Calambokidis et al. 2002).

The estimates or the trend did not appear to be biased or an artifact of quality screening of photographs that could have changed over the years. We used a subset of our photo-ID sample to examine abundance in order to evaluate whether our quality selection criteria for both comparing whales and adding new whales to the catalog could have biased any of these estimates. All photographic identifications from 1994 to 2002 were re-examined and rated as to whether the photographic quality could have been low enough to prevent them from being matched or to have resulted in other photographs of this quality not being used in our sample. This quality screening removed an average of 18% of the unique identifications each year. New mark-recapture estimates based excluding all these marginal quality photographs yielded almost identical results to the original estimates (Table 16). This confirmed that our selection criteria does not appear to be biasing the estimates and has not changed over the years to bias the trends.

The broader regional coverage we obtained 2002, especially the expanded effort off Oregon, contributed partly to the higher estimates. Of the 32 humpback whales identified off Oregon, only half (16) had been identified previously in our research and only three (9%) were animals that had been identified in 2001 (a low recapture rate elevates the mark-recapture estimate). This compares with 208 of the 275 whales (76%) identified off California (and not off Oregon) having been seen previously and 80 of these seen in 2001 (29%). The magnitude of this

bias is fairly small and the estimate for 2001-2002 excluding Oregon was slightly lower at 924. Estimates calculated for all years excluding Oregon show a similar trend as the overall data with slightly lower estimates for the estimates involving years where there had been whales identied off Oregon (Table 16, Figure 8).

From 1991 through 1999, humpback whale abundance estimates had increased steadily from 569 to 1,016 (Figure 8). This represents an increase of 9% per year. The estimates from 1999 to 2001 represented the first substantial decline in numbers in this trend. The two possible short-term phenomena suspected to be responsible for a decreased survival in humpback whales were the effects of the 1997-98 *El Niño* and the demoic acid outbreak in 1998 (Scholin et al. 2000). This *El Niño* was considered severe and resulted in lower upwelling and productivity off California from spring 1997 through the fall of 1998. Zooplankton declines appeared to be more severe in many areas in 1998. Lower prey availability for humpback whales during the 1998 feeding seasons could produce a lower survival of animals over the following winter fasting period.

Jolly-Seber multi-year mark-recapture abundance estimates for humpback whales showed a similar pattern as the inter-year Petersen estimates (Table 17, Figure 8). These estimates show the abundance climbing through 1998 then declining for 1999 and 2000 before increasing aging in 2001. There is a sharp decrease in the survival rate for animals starting in 1998, going from 0.95 to 0.99 for all except one year from 1991 to 1997 and then dropping to 0.80 for 1998 and 0.85 in 1999 before rising back sharply to over 1 in 2000 (the last year an estimate can be made).

The most recent abundance estimates while still well below the original trend for 1991-98, do not suggest as dramatic a reduction in numbers as was evident in the previous two years. It is also possible that the slightly higher than expected recent estimate is the result of chance variation. It may require one more year to evaluate the true magnitude of the decline that occurred after 1998.

Blue whales

We were able to obtain a more accurate updated blue whale abundance estimate incorporating the 2002 data. Unbiased blue whale abundance estimates can only be determined when we have representative samples of whales from both inshore and offshore waters. We have relied on identification photographs obtained during the SWFSC systematic surveys conducted off Mexico, California, Oregon, and Washington for these samples. This is a requirement for blue whales and not for humpback whales for two reasons: 1) a large portion of the blue whale population feeds in waters farther offshore than we are able to sample in our coastal surveys, and 2) blue whales that feed offshore and inshore do not randomly redistribute between these strata between sample periods (years). We therefore use the identifications from the SWFSC systematic surveys as a representative sample that can be compared to our larger but not representative coastal sample.

In our previous report (Calambokidis et al. 2002) we were unable to estimate blue whale abundance accurately because relatively few blue whale identifications were obtained during the

2001 SWFSC cruises as a result of the low sighting rate of blue whales during these cruises. Only 13 groups of blue whales, representing 16 whales were approached for photographic identification and good quality identification photographs obtained for 13 of them (12 with acceptable right side and 9 with acceptable left side photos). The reason for the lower than expected sighting rates in the 2001 survey may in part be the clumped distribution of blue whales seen in late summer 2001.

For this report we calculated abundance using blue whale identifications from three surveys that were systematic: 1) 12 identifications (9 lefts and 12 right sides) from the 2001 SWFSC cruise off California, Oregon, and Washington, 2) 12 identifications (7 left and 8 right sides) from 2000 SWFSC cruises to and from the ETP cruises that obtained identifications off the west coast of Baja, and 3) 4 identifications (both right and lefts) from a 2002 SWFSC cruise headed offshore from San Diego headed towards Hawaii. For the larger but non-systematic identifications in the mark-recapture, we used all other identifications made by Cascadia personnel and collaborators off California from 2000 to 2002.

Pooling of these samples from 2000 to 2002 provided an adequate sample to estimate abundance (Table 18) with a similar level of confidence as in past years (Calambokidis and Barlow In press). Estimates for 2000-2002 for right and left sides were 1,567 (CV=0.32) and 1,953 (CV=0.33), respectively, averaging 1,760. This is slightly lower than estimates from 1991-93 and 1995-97 using similar procedures. While these estimates are not significantly different from those in the early and mid-1990s, they do not suggest that blue whale populations have been increasing over the last decade has was the case with humpback whales.

Tagging

We had success deploying all three types of tags on blue and humpback whales in 2002. In 46 approaches of blue whales in 2002, we were able to successfully attach a tag in 25 occasions (Table 19-20). This is a much higher rate than in past years and has reflected a steadily increasing success rate since we started. While our success rate with deploying tags was higher in 2002, we did experience problems achieving longer deployments of Crittercams compared to previous years. This appears to have been due to several factors that resulted in leaks and loss of suction.

Our longest deployment to date was made with the Burgess Bio-probe attached to the trailing animal of a pair of San Diego on 30 June 2002. Biopsy samples revealed this to be a lead pregnant female with the tagged trail animal being a male. The tag stayed on somewhere between 25 and 39 hours. The 15 hours of data obtained before the memory filled up provided insights into diving and vocal behavior (Figure 9). Dive record for this animal showed a dramatic shift in diving behavior over time going from: 1) spiked dives while traveling to 2) sawtooth dives as it shifted to feeding in one area, then 3) progressively shallower feeding dives with the advent of darkness and the vertical migration of krill, 4) a resting mode at night with frequent shallow dives as the animal milled slowly near the surface, and 5) a return to sawtooth feeding dives that become progressively deeper with the onset of daylight (Figure 9).

While we had not initially identified this tagged animal as a calling whale, the tag data revealed it was producing intermittent calls throughout the night (Figure 9). These calls were of a consistent intensity and were produced in some cases when the lead whale was surfacing, indicating the tagged whale was producing the calls. Calls were produced at a very consistent shallow depth (12-25 meters) even though the whale was sometimes diving to close to 200 m in other portions of the dive.

Loud calls were also heard on one of the Crittercam and dTag deployments in 2002. Calls were heard on the dTag deployment on the trailing animal of a traveling pair in the Santa Barbara Channel. They were also heard on one Crittercam deployment on the trailing animal of a group of three whales in the Santa Barbara Channel. The tagged animal slows to a low speed and a second animal is seen next to the tagged animal during the period of the call.

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Bill Burgess of Greeneridge Scientific Services developed the Bio-probe and assisted in deployments. Joe Olson developed the attachment method for the acoustic tag. Mark McDonald assisted in tag deployment. Mark Johnson, Becky Woodward, and Jeremy Winn provided were responsible for providing and assisting in deployment of the WHOI dTag. Ski Lanowitz skippered one of the support boats during tagging. SIO personnel and the crew of the Sproul assisted in the work off southern California. Crittercam was developed by Greg Marshall of National Geographic. John Francis, Mehdi Baktiari, Pat Greene, Mike Heithouse, and Kyler Abernathy assisted in Crittercam deployments.

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TABLES AND FIGURES

Tables

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Table 1. Summary of field effort by Cascadia Research in 2002 aimed primarily at humpback and blue whales off the California, Oregon and Washington coasts.

							Time		Durat		Humpback whales			Blue whales			Gray whales			Other
Date	Ves	Lead	Launch	Month	Region	Other activities	Beg	End	(h)	nmi	S#	A#	ID#	S#	A#	ID#	S#	A#	ID#	Species IDed
01-May-02	N1	JAC	Everett	5	WA	ER	8:15	21:30	13.3	138.6							2	4	4	
12-May-02	N2	TEC	Moss Landing	5	CCA		8:10	13:15	5.1	31.4	6	12	8							
11-Jun-02	N2	TEC	San Luis	6	SCA		8:06	17:00	8.9	75.6	8	18	13	14	16	10				
12-Jun-02	N2	TEC	San Luis	6	SCA		12:26	14:30	2.1	16.9	2	3	2							
18-Jun-02	N2	JAC	Santa Barbara	6	SCA	Tag	9:50	16:27	6.6	55.1										
19-Jun-02	N2	JAC	Santa Barbara	6	SCA	Tag	6:40	15:35	8.9	60.3	6	10	6							
19-Jun-02	SOL	JW	Santa Barbara	6	SCA		6:42	15:35	8.9	61.4	3	7	1							
20-Jun-02	N2	JAC	Santa Barbara	6	SCA	Tag	6:34	18:50	12.3	74.1	9	16	6							
20-Jun-02	SOL	JW	Santa Barbara	6	SCA		6:58	17:23	10.4	54.1	6	13	0							
21-Jun-02	N2	JAC	Santa Barbara	6	SCA	Tag	7:30	15:34	8.1	48.3										1 PM
21-Jun-02	SOL	JW	Santa Barbara	6	SCA		7:56	14:22	6.4	42.1										
22-Jun-02	N2	JAC	Santa Barbara	6	SCA	Tag	6:20	16:19	10.0	62.7	9	13	1							
22-Jun-02	SOL	MO	Santa Barbara	6	SCA		7:05	15:50	8.8	46.3	7	11	0							
23-Jun-02	N2	JAC	Santa Barbara	6	SCA	Tag	6:30	16:40	10.2	66.1	4	9	3	2	3	2				
23-Jun-02	SOL	JW	Santa Barbara	6	SCA		6:46	17:00	10.2	53.8	4	9	0	1	2	0				
24-Jun-02	N2	JAC	Santa Barbara	6	SCA	Tag	8:50	21:14	12.4	77.8				1	1	1				
24-Jun-02	SOL	JW	Santa Barbara	6	SCA		8:46	19:20	10.6	56.8				1	1	0				
25-Jun-02	N2	JAC	Santa Barbara	6	SCA	Tag	10:25	19:36	9.2	71.1				7	12	3				
26-Jun-02	N2	JAC	Sproul	6	SCA	Tag	7:30	20:30	13.0	41.4	1	1	0	52	69	33				
26-Jun-02	SP			6	SCA	Opportunistic ID								1	2	2				
27-Jun-02	N2	JAC	Sproul	6	SCA	Tag	6:30	17:24	10.9	36.2				46	58	35				
29-Jun-02	N2	JAC	Sproul	6	SCA	Tag	19:15	20:57	1.7	8.4										
30-Jun-02	N2	JAC	Sproul	6	SCA	Tag	0:00	23:30	23.5	29.3				4	5	4				
01-Jul-02	N2	JAC	Sproul	7	SCA	Tag	0:15	4:30	4.3	5.0										
02-Jul-02	N2	TEC	San Diego	7	SCA	Tag p/u	8:30	16:48	8.3	85.5				1	2	2				
03-Jul-02	N2	TEC	Santa Barbara	7	SCA		6:35	16:05	9.5	96.7				6	8	8				
11-Jul-02	N2	TEC	Half-Moon Bay	7	CCA		8:00	17:26	9.4	112.6	5	8	6							
12-Jul-02	N2	TEC	Half-Moon Bay	7	CCA		6:41	18:55	12.2	103.5	20	43	20							
16-Jul-02	N1	JAC	La Push	7	WA		7:55	21:30	13.6	135.9	8	9	9							
19-Jul-02	N2	TEC	Santa Cruz	7	CCA		7:06	16:40	9.6	108.6	3	3	0	1	1	0				
20-Jul-02	N2	TEC	Moss Landing	7	CCA		7:06	16:30	9.4	86.7	7	13	9	1	1	1				
21-Jul-02	N2	TEC	Bodega	7	CCA		6:50	19:42	12.9	138.1	11	24	13	1	2	1				
22-Jul-02	N2	TEC	Bodega	7	CCA		6:28	19:45	13.3	134.2	15	30	18	8	11	7				1 BP
27-Jul-02	N2	TEC	Santa Barbara	7	CCA		6:30	18:58	12.5	129.0	1	1	0	24	33	20				
28-Jul-02	N2	TEC	Gaviota	7	SCA		7:51	19:13	11.4	85.9				44	55	45				
29-Jul	N2	TEC	San Luis	7	SCA		6:33	10:45	4.2	35.5	3	7	6							
30-Jul	N2	TEC	Half-Moon Bay	7	CCA		6:40	19:20	12.7	108.6	21	36	24	6	9	9				
1-Aug	N2	TEC	Ft. Bragg	8	NCA		6:50	19:10	12.3	138.6	9	19	11							1 OO
10-Aug	N2	JAC	Newport	8	OR	CC, abort	7:55	10:00	2.1	19.8										
11-Aug	N2	JAC	Newport	8	OR	CC	9:10	17:13	8.1	72.5										
12-Aug	N2	JAC	Newport	8	OR	CC , abort	8:41	11:15	2.6	24.2										
13-Aug	N2	JAC	Newport-Florenc	8	OR	CC	7:25	17:40	10.3	81.0	4	6	3							
15-Aug	N2	JAC	Salmon Hbr	8	OR	Cst. Gd. turns back	8:10	9:00	0.8	0.0										
16-Aug	N2	JAC	Salmon Hbr	8	OR	CC	8:30	20:30	12.0	94.4	7	12	5							
17-Aug	N2	JAC	Pt Orford	8	OR	ER	9:20	14:45	5.4	20.1							7	13	12	
17-Aug	N2	JAC	Pt St George	8	NCA	ER	17:35	19:43	2.1	16.2							1	1	1	
19-Aug	N2	JAC	SD-Sproul	8	SCA		7:00	19:36	12.6	110.1										
20-Aug	N2	JAC	Sproul	8	SCA	DIFAR array	7:05	20:08	13.1	52.0										1 BP
21-Aug	N2	JAC	Sproul	8	SCA		6:55	17:50	10.9	60.9										11 BP
24-Aug	N2	JAC	Santa Barbara	8	SCA	Acoustic tag	7:00	14:36	7.6	67.6				2	2	0				
25-Aug	N2	JAC	Monterey	8	CCA		8:38	16:18	7.7	48.4				3	5	3				
6-Sep	N2	JAC	Pt Orford	9	OR		9:25	19:25	10.0	80.3	1	2	2				26	47	47	
7-Sep	N2	JAC	Florence	9	OR		8:30	21:13	12.7	104.4	13	26	20							
16-Sep	N2	JAC	Monterey	9	CCA	CC	7:50	14:40	6.8	46.9				2	3	2				
17-Sep	N1	TEC	Pt St George	9	NCA	ER, Pr weather	10:42	12:54	2.2	12.3							1	2	1	
17-Sep	N2	JAC	Monterey	9	CCA	CC	7:45	15:24	7.7	53.4				1	2	1				
18-Sep	N1	TEC	Pt Arena	9	NCA	Pr weather	8:08	14:17	6.2	66.2										
18-Sep	N2	JAC	Monterey	9	CCA	CC	8:55	19:30	10.6	63.2	1	3	1	4	5	1				
19-Sep	N1	TEC	Bodega	9	CCA		7:30	19:16	11.8	115.1	30	67	51	4	8	5				
19-Sep	N2	JAC	Monterey	9	CCA	CC	7:45	17:20	9.6	48.9				8	11	1				
20-Sep	N1	TEC	Monterey	9	CCA		8:01	12:05	4.1	41.4				3	4	2				
20-Sep	N2	JAC	Monterey	9	CCA	CC, weather abort	8:02	12:15	4.2	21.2				1	2	0				
21-Sep	N1	TEC	Santa Barbara	9	SCA		9:22	18:30	9.1	91.2				12	16	11				
21-Sep	N2	JAC	Santa Barbara	9	SCA	CC	7:49	18:50	11.0	57.4				8	14	4				
22-Sep	N1	TEC	Santa Barbara	9	SCA		7:24	17:12	9.8	86.2				16	25	17				
22-Sep	N2	JAC	Santa Barbara	9	SCA	CC	7:20	17:21	10.0	50.6				19	28	14				
22-Sep	SOL		Santa Barbara	9	SCA		9:48	13:15	3.5	40.5				7	15	8				
23-Sep	N1	TEC	Santa Barbara	9	SCA		7:39	15:43	8.1	66.4				23	31	26				
23-Sep	N2	JAC	Santa Barbara	9	SCA	CC	7:38	15:49	8.2	42.1				18	29	19				
24-Sep	N1	JAC	Santa Barbara	9	SCA	CC	7:40	14:20	6.7	45.1				8	13	2				
24-Sep	N2	TEC	Half-Moon Bay	9	CCA		8:15	16:49	8.6	71.3	5	12	7	1	3	3				
25-Sep	N1	TEC	Half-Moon Bay	9	CCA		8:15	18:36	10.4	81.1	18	36	19	13	20	15				
27-Sep	N1	TEC	Half-Moon Bay	9	CCA		7:45	19:21	11.6	120.6	16	42	17	8	12	9				
28-Sep	N1	TEC	Bodega	9	CCA		7:30	18:52	11.4	75.9	12	22	9	7	9	8				
30-Sep	N1	TEC	Ft. Bragg	9	NCA		7:24	16:35	9.2	118.7	4	10	11	1	2	1				
4-Oct	N2	TEC	San Luis	10	SCA		7:48	16:45	9.0	57.7	8	36	16	17	23	17				
5-Oct	N2	TEC	San Luis	10	SCA		7:43	16:31	8.8	79.4	6	12	2	13	20	17				
7-Oct	N2	TEC	Bodega	10	CCA		7:16	17:21	10.1	119.6	5	10	7	1	2	1				
8-Oct	N2	TEC	Bodega	10	CCA		12:12	19:25	7.2	92.8	5	11	8	4	8	6				
12-Oct	N1	TEC	Shelter Cove	10	NCA		8:45	16:27	7.7	112.7										
13-Oct	N1	TEC	Pt St George	10	NCA		7:47	18:40	10.9	143.4	7	14	9							
14-Oct	N1	TEC	Port Orford	10	OR		8:12	17:35	9.4	60.2							22	35	39	
15-Oct	N1	TEC	Coos Bay	10	OR		7:39	17:00	9.4	137.0										
16-Oct	N1	TEC	Florence	10	OR		8:06	18:51	10.8	140.4	4	8	7							
29-Oct	N2	TEC	San Luis	10	SCA		6:39	16:14	9.6	105.5	2	8	4	2	2	3				
30-Oct	N2	TEC	Santa Barbara	10	SCA		7:02	17:20	10.3	106.0	4	7	5	5	5	6				
31-Oct	N2	TEC	Santa Barbara	10	SCA		6:56	17:01	10.1	97.5	2	4	4	14	27	18				
3-Nov	N2	TEC	Sproul	11	SCA	Track caller	6:35	17:24	10.8	50.7	1	3	3	1	1	1				2 BP
6-Nov	N2	TEC	Gaviota	11	SCA		7:52	16:25	8.6	69.6	18	46	37	7	10	9				5 OO
Totals							89	days	798	6,352	341	712	403	454	648	413	59	102	104	

Table 2. Summary of field effort by Cascadia Research in 2002 aimed primarily at humpback and blue whales off the coast of British Columbia.

						Time		Durat		Humpback whales			Gray whales			Other
Date	**Ves**	**Lead**	**Launch**	**Regio**	**Other activities**	**Beg**	**End**	**(h)**	**nmi**	**S#**	**A#**	**ID#**	**S#**	**A#**	**ID#**	**Species IDed**
31-Jul	N1	JAC	Pt Hardy	NVI		6:15	15:30	9.3	117.2				6	7	7	
1-Aug	N1	JAC	*Curve of Time*	NBC		10:45	22:00	11.3	63.9	5	7		1	1	1	4 OO, 1 PM
2-Aug	N1	JAC	*Curve of Time*	NBC		13:00	20:55	7.9	30.0	10	17					
3-Aug	N1	JAC	*Curve of Time*	NBC		14:40	22:15	7.6	56.0	2	3					
4-Aug	N1	JAC	*Curve of Time*	NBC	Search for ER on QC	18:15	22:30	4.3	56.9							
5-Aug	N1	JAC	*Curve of Time*	NBC		10:10	17:15	7.1	52.9	3	3					3 BP
6-Aug	N1	JAC	*Curve of Time*	NBC	BP ID/biopsy	14:55	21:40	6.8	40.5	7	7					
7-Aug	N1	JAC	*Curve of Time*	NBC	ER	7:35	17:31	9.9	80.9	8	11		19	22	24	
Totals								55	381	35	48	*	20	23	25	

* Identifications beings compiled and matched by Department of Fisheries and Oceans

Table 3. Summary of effort and photo-ID from OCNMS surveys aboard the *McArthur* and RHIB and opportunistic identifications in 2002.

			Time		Durat		Humpback whales			Other
Date	**Ves**	**Lead**	**Beg**	**End**	**(h)**	**nmi**	**S#**	**A#**	**ID#**	**Species IDed**
12-Jun-02	*McArthur*	A. Douglas	Transect survey - opport. II				3	4	0	
13-Jun-02	*AR2*	A. Douglas	7:54	15:56	8.0	60.5	7	10	3	
14-Jun-02	*AR2*	A. Douglas	Transect survey - opport. II				10	13	8	
14-Jun-02	*McArthur*	A. Douglas	6:58	7:38	0.7	2.9	1	3	0	
15-Jun-02	*AR2*	A. Douglas	8:55	11:24	2.5	20.4	1	1	0	5 OO
16-Jun-02	*AR2*	A. Douglas	9:29	12:17	2.8	25.2	5	10	5	
16-Jun-02	*McArthur*	A. Douglas	Transect survey - opport. II				4	5	3	
18-Jun-02	*AR2*	A. Douglas	8:18	20:04	11.8	47.8	3	10	7	
18-Jun-02	*McArthur*	A. Douglas	Transect survey - opport. II				1	2	1	
13-Aug-02	*Tatoosh*	E. Bowlby	Opportunistic ID				1	1	1	
21-Aug-02	*Tatoosh*	E. Bowlby	Opportunistic ID				1	1	1	
22-Aug-02	*Tatoosh*	E. Bowlby	Opportunistic ID				1	1	1	
05-Sep-02	*Tatoosh*	J. Rosepeppe	Opportunistic ID				1	4	2	
Total					25.8	156.9	39	65	32	

Table 4. Summary of effort and photo-IDs by CINMS Whale Corps in Santa Barbara Channel in 2002.

		Time		Durat		Humpback whales			Blue whales			Other
Date	**Ves**	**Beg**	**End**	**(h)**	**nmi**	**S#**	**A#**	**ID#**	**S#**	**A#**	**ID#**	**Species IDed**
24-May-02	DD	8:05	17:17	9.2	53.3	4	8	3				
26-May-02	CON	8:10	17:00	8.8	90.9	6	14	4	2	4	1	
02-Jun-02	RG	8:15	13:22	5.1	40.2	1	2	1				5 OO
05-Jun-02	CON	8:40	12:55	4.3	53.8	2	3	2	1	1	0	
08-Jun-02	CON	8:10	13:00	4.8	92.3	2	5	1	2	6	0	
09-Jun-02	CON	13:15	16:45	3.5	44.4	4	7	0	1	3	0	
09-Jun-02	RG	8:30	12:05	3.6	18.4	1	2	0				
11-Jun-02	CON	8:20	13:05	4.8	66.0	4	8	2	1	2	2	
12-Jun-02	CON	8:15	13:00	4.8	86.6	4	18	3				
14-Jun-02	CON	10:00	12:45	2.8	16.1	1	2	1				
15-Jun-02	CON	8:10	11:51	3.7	50.8	4	9	3	1	2	1	
16-Jun-02	CON	8:15	13:00	4.8	42.7	3	14	2				
17-Jun-02	CON	8:15	13:30	5.3	29.5	2	2	1				
19-Jun-02	CON	8:02	13:30	5.5	21.0	2	3	0				
20-Jun-02	CON	8:07	12:40	4.6	50.6	2	21	1				
23-Jun-02	CON	8:00	12:07	4.1	45.5	3	12	3	1	2	0	
26-Jun-02	CON	8:12	12:20	4.1	51.1	2	7	1	1	1	1	
30-Jun-02	CON	13:00	17:15	4.3	55.0	2	6	2				
01-Jul-02	CON	8:15	12:15	4.0	47.7	3	7	2	5	9	1	
04-Jul-02	CON	8:00	12:21	4.4	55.4				2	8	2	
05-Jul-02	CON	8:15	12:15	4.0	61.1				1	6	1	
06-Jul-02	RG	8:10	12:15	4.1	37.6	1	1	0	2	9	0	
08-Jul-02	RG	8:55	14:00	5.1	42.4	1	2	0	1	4	0	
11-Jul-02	CON	8:20	12:50	4.5	45.1				1	1	2	
18-Jul-02	CON	8:30	13:00	4.5	43.7				1	4	0	
21-Jul-02	CON	7:59	12:19	4.3	66.8	1	2	0	1	20	5	
23-Jul-02	CON	8:15	13:00	4.8	64.5				3	13	2	
24-Jul-02	CON	8:15	13:00	4.8	68.1				3	3	4	
26-Jul-02	CON	8:15	12:30	4.3	38.7				6	12	1	
02-Aug-02	CON	8:13	13:02	4.8	59.4	1	2	1	3	5	2	
04-Aug-02	CON	13:31	17:20	3.8	57.5	2	6	1	1	6	2	
06-Aug-02	CON	8:18	12:59	4.7	54.4	1	2	1	2	14	2	
08-Aug-02	CON	9:30	11:30	2.0	8.7				2	4	2	
09-Aug-02	CON	9:00	12:38	3.6	39.2				1	1	1	
11-Aug-02	CON	8:10	17:20	9.2	110.3				11	21	8	
13-Aug-02	CON	9:40	13:15	3.6	39.8				8	10	5	
15-Aug-02	CON	8:06	13:30	5.4	61.5	1	2	1	4	7	3	
16-Aug-02	CON	9:05	13:00	3.9	44.2	1	2	0	3	5	0	
17-Aug-02	CON	8:05	13:00	4.9	61.6	1	6	0	2	3	0	
18-Aug-02	CON	8:20	17:20	9.0	126.6	2	6	0	10	35	8	
20-Aug-02	CON	8:20	13:05	4.8	70.4	2	4	1	1	20	3	
21-Aug-02	CON	8:05	11:35	3.5	35.8	2	4	0	7	15	4	
25-Aug-02	CON	8:45	13:00	4.3	41.9				1	3	0	
28-Aug-02	CON	8:11	13:12	5.0	64.0				2	12	2	
29-Aug-02	CON	8:30	13:00	4.5	46.6				3	8	0	
30-Aug-02	CON	8:10	12:55	4.8	83.2	2	4	3	7	16	1	
02-Sep-02	CON	8:53	17:00	8.1	87.9				3	70	10	
06-Sep-02	CON	9:16	12:00	2.7	25.7				4	14	1	
07-Sep-02	CON	13:00	17:23	4.4	51.9				2	3	1	
13-Sep-02	CON	8:30	12:32	4.0	43.2				1	24	1	
20-Oct-02	CON	8:21	12:45	4.4	35.7	1	5	1	1	5	2	
26-Oct-02	CON	8:00	11:45	3.8	43.7	3	4	0	2	5	0	
		52	days	245	2772	74	202	41	117	416	81	

Table 5. Summary of effort and photo-IDs by Peggy Stapp and Nancy Black in Monterey Bay in 2002.

		Time		Durat		Humpback whales			Blue whales			Other
Date	**Ves**	**Beg**	**End**	**(h)**	**nmi**	**S#**	**A#**	**ID#**	**S#**	**A#**	**ID#**	**Species IDed**
20-Apr-02	SW2	7:10	15:00	7.8	29.8	10	23	5				
21-Apr-02	SW2	7:48	14:14	6.4	6.3	6	19	5				
21-Apr-02	ZOD	14:38	15:53	1.3	0.3	2	5	4				
23-Apr-02	SW2	10:07	15:44	5.6	24.8	6	12	2				
24-Apr-02	ZOD	9:01	15:02	6.0	39.9							
25-Apr-02	INF	7:02	14:00	7.0	40.3	5	8	1				
26-Apr-02	SW2	10:00	16:10	6.2	15.8	4	11	5				
27-Apr-02	SW2	7:09	16:40	9.5	36.2	15	29	6				
29-Apr-02	ZOD	8:50	14:00	5.2	28.3	1	2	1				
01-May-02	SW2	9:00	13:54	4.9	39.1	1	2	1				
02-May-02	SW2	9:02	13:42	4.7	25.3	2	5	3				
03-May-02	ZOD	7:20	12:55	5.6	30.0	2	6	2				
04-May-02	ZOD	8:00	14:55	6.9	21.1	1	6	0				
05-May-02	ZOD	7:30	15:30	8.0	31.0	4	7	1				
06-May-02	ZOD	7:00	12:55	5.9	29.8	3	6	2				
30-Aug-02	SW2	9:07	15:30	6.4	36.9	1	1	1	3	5	3	15 OO
31-Aug-02	SW2	9:14	14:40	5.4	29.0	4	6	1	4	8	3	
01-Sep-02	SW2	9:10	14:45	5.6	26.6	1	3	1	1	2	0	
02-Sep-02	SW2	8:30	12:33	4.1	31.8	3	7	3	1	7	0	
03-Sep-02	SW2	8:00	15:45	7.8	46.9	2	4	1	5	13	11	
04-Sep-02	SW2	8:00	15:45	7.8	64.6	4	10	4	6	13	1	
05-Sep-02	SW2	7:30	11:45	4.3	23.9				4	7	3	
06-Sep-02	SW2	8:06	16:02	7.9	63.1	2	5	2	3	6	0	3 OO
07-Sep-02	SW2	9:14	18:02	8.8	49.7				5	12	0	3 OO
08-Sep-02	SW2	9:08	15:00	5.9	44.2	2	5	0	4	21	3	
09-Sep-02	SW2	9:14	15:05	5.9	45.3	1	2	1	7	32	1	
14-Sep-02	SW2	7:45	15:25	7.7	45.2				1	3	1	5 OO
15-Sep-02	SW2	9:01	14:55	5.9	43.2							4 OO
16-Sep-02	SW2	9:08	14:10	5.0	28.3				4	7	2	
18-Sep-02	SW2	9:06	14:32	5.4	35.6				1	9	2	
20-Sep-02	SW2	8:59	13:28	4.5	32.8				1	1	1	
21-Sep-02	SW2	9:03	14:05	5.0	31.0				1	1	1	
		32	days	194	1076	82	184	52	51	147	32	

Table 6. Summary of effort and identifications by type and region in 2002. Hours and nmi do not include all incidental or opportunistic effort.

Type/Region	**Dates**		**Vessel**	**Hours**	**nmi**	**Humpback whales**			**Blue whales**			**Gray whales**		
	Start	**End**	**days**			**S#**	**A#**	**ID#**	**S#**	**A#**	**ID#**	**S#**	**A#**	**ID#**
Cascadia RHIBS California, Oregon, Washington	1-May	6-Nov	89	798	6,352	341	712	403	454	648	413	59	102	104
Curve of Time & Cascadia RHIB Central British Columbia	31-Jul	7-Aug	15	55	381	35	48	*				20	23	25
OCNMS surveys (*McArthur, RHIB, Tatoo* surveys off Washington	12-Jun	5-Sep	13	26	157	39	65	32						
CINMS Whale Corps Santa Barbara Channel	#####	26-Oct	52	245	2772	74	202	41	117	416	81			
Monterey Whale Watch (N. Black and P Sta Monterey Bay	20-Apr	21-Sep	32	194	1076	82	184	52	51	147	32			
Other opportunistic (SWFSC, B. Alps) S California			3			1	1	1	3	6	4			
Total						572	1212	529	625	1217	530	79	125	129

* Identifications beings compiled and matched by Department of Fisheries and Oceans

Table 7. Summary of surveys conducted by Cascadia in 2002 month and region.

Region	Code	Month 5	6	7	8	9	10	11	Total
Southern California	SCA		21	5	4	8	5	2	45
Central California	CCA	1		8	1	11	2		23
Northern California	NCA				2	3	2		7
Oregon	OR				7	2	3		12
Washington	WA	1		1					2
Central British Columbia	CBC			1	14				15
Grand Total		2	21	15	28	24	12	2	104

Table 8. Number of blue whales identified in 2002 incl.4 SWFSC offshore IDs and opportunistic identifications.

Region	Code	Month 5	6	7	8	9	10	11	Total
S Southern California Bight	31		4	4				1	9
N Southern California Bight	32			48				5	53
Santa Barbara Channel	33	1	80	43	43	114	26	4	311
Offshore S California	39			2					2
Pt Conception to Buchon	41		10				37		47
Monterey Bay	51			1	9	33			43
Half-Moon Bay	52			2		2			4
Gulf of the Farallones	53			15		38	1		54
Bodega to Pt Arena	54						6		6
Pt. Arena to Mendocino	61					1			1
Grand Total		1	94	115	52	188	70	10	530

Table 9. Number of humpback whales identified in 2002 including SWFSC cruises and opportunistic surveys.

Region	Code	Month 02	04	05	06	07	08	09	10	11	Total
S Southern California Bight	31									3	3
N Southern California Bight	32	1									1
Santa Barbara Channel	33			7	40	2	8		10	37	104
Pt Conception to Buchon	41				15	6			22		43
Monterey Bay	51		29	17		9	2	13			70
Half-Moon Bay	52							43			43
Gulf of the Farallones	53					81		60	15		156
Pt. Arena to Mendocino	61						11	11			22
N California	63								9		9
S Oregon	71							2			2
Central Oregon	72						8	20	7		35
N Washington/BC	76				27	9	3	2			41
Grand Total		1	29	24	82	107	32	151	63	40	529

Table 10. Summary of skin samples by species and type collected in 2002

Region/type	Blue	Fin	Humpback	Gray	Sperm	Orca	All
Califonria/Oregon/Washington							
Biopsy	10	3	42	1		3	59
Skin recovered from tags	18		1				19
Sloughed skin	1						1
Stranded animals		3			2		5
Central British Columbia							
Biopsy		3	23		1		27
Total skin samples	29	9	66	1	3	3	111

Table 11. List of skin samples obtained in off California, Oregon, and Washington in 2002.

Samples	Date/time	Type	Sp	Region	Pers	Latitude	Longitde	Num	Ves	SN#	Reaction	Photo-ID	Notes	ID	SWFSC #
020501-1	5/1/2002 20:15	Biopsy	ER	Puget Sound	JAC	48 00.28	122 13.37	1 of 3	N1	8	NR	ID-53	Biopsy ID 95% sure	53	
020623-1	6/23/2002 11:19	Skin from tag attchmt.	BM	SBC	JAC	34 08.01	119 53.21	Trail of 2	N2	8	NR	JAC 3/21-E	from robot head	370	
020624-1	6/24/2002 12:34	Skin from tag attchmt.	BM	SBC	JAC	34 08.34	119 56.11	Single	N2	1		JAC 4/1-17 Col/1-10		951	
020625-1	6/25/2002 15:00	Skin from tag cup	BM	SBC	JAC	34 15.82	120 12.42	Single	N2	1		JAC 4/1-17 Col/1-10	Same whale as 020624-1	951	
020626-1	6/26/2002 11:36	Biopsy	BM	SBC	JAC	34 06.90	120 04.65	trail of 2	N2	15	NR	JAC 5/22-24		1864	
020626-2	6/26/2002 12:00	Very sm skin from tag	BM	SBC	JAC	34 06.65	120 04.79	Single	N2	4		JAC 5/1,3-6, CP/11-2	May not be enough	1864	
020626-3	6/26/2002 12:45	Biopsy	BM	SBC	JAC	34 06.72	120 05.06	trail of 2	N2	18	NR	JAC 5/26-31,CP 13-15	Small skin from crack tip/floatation	939	
020626-4A&B	6/26/2002 12:56	Biopsy	BM	SBC	JAC	34 06.52	120 04.97	Lead of 2	N2	19	NR	JAC CP/16-20	Could be same pair as above, A-genetics, B	763	
020626-5A&B	6/26/2002 14:00	Biopsy	BM	SBC	JAC	34 06.80	120 03.35	trail of 2	N2	23	NR	JAC 6/11-12	A-genetics, B pregancy (frozen)	475	
020626-6	6/26/2002 14:05	Biopsy	BM	SBC	JAC	34 06.71	120 03.39	Single	N2	24	Extends SS dive	JAC 6/13-14		775	
020627-1	6/27/2002 7:41	Skin from tag cup and hol	BM	SBC	JAC	34 06.68	120 05.61	Single	N2	2		JAC 7/16		1852	
020627-2A&B	6/27/2002 14:25	Biopsy	BM	SBC	JAC	34 06.70	120 04.88	Single	N2	37	NR	JAC 9/01	A-genetics, B pregancy (frozen)	1847	
020627-3A&B	6/27/2002 14:57	Biopsy	BM	SBC	JAC	34 06.50	120 05.06	Single	N2	42	NR	JAC 9/8-9	A-genetics, B pregancy (frozen)	1087	
020630-1	6/30/2002 12:40	Biopsy	BM	SC	JAC	32 38.95	117 26.92	Single	N2	201	NR	JAC 10/1-3	Very small sample	445	
020630-2	6/30/2002 12:19	Skin from tag cup and mes	BM	SC	JAC	32 40.61	117 25.36	Single	N2	201		JAC 10/1-3	Incl. mesh, same animal as 020630-1	445	
020630-3A&B	6/30/2002 17:00	Biopsy	BM	SC	JAC	32 50.98	117 22.50	Lead of 2	N2	202	NR	JAC 10/6-25	A-genetics, B pregancy (frozen)	445	
020630-4	6/30/2002 17:14	Biopsy	BM	SC	JAC	32 51.23	117 22.47	Trail of 2	N2	202	NR	JAC 10/6-25	Tagged whale	336	
CRC-020716-1	7/16/2002 13:04	Biopsy	MN	WA	JAC	47 13.04	124 37.61	Single	N1	4	NR	JAC 13/3-4		-	29816
CRC-020716-2A	7/16/2002 13:36	Biopsy	MN	WA	JAC	47 16.80	124 40.98	1 of 2	N1	5	Fluke Swish	JAC 13/5-15	A-skin, B-blubber	13545	29817
CRC-020716-3	7/16/2002 14:30	Biopsy	MN	WA	JAC	48 18.03	125 38.53	1 of 2	N1	5	Flick			13566	29818
CRC-020716-4A	7/16/2002 16:55	Biopsy	MN	WA	JAC	48 22.36	125 37.50	Single	N1	10	Flick	JAC 13/19-21		13544	29819
CRC-020716-5A	7/16/2002 17:38	Biopsy	MN	WA	JAC	48 22.74	125 38.61	Single	N1	11	High Tail Rise	JAC 13/22-24		13609	29820
CRC-020716-6A	7/16/2002 18:21	Biopsy	MN	WA	JAC	48 21.24	125 37.60	Single	N1	12	Flick	JAC 13/25-26		14028	29821
CRC-020730-1A	7/30/2002 16:17	Biopsy	MN	CA	TEC	37 40.21	123 05.29	Single	N2	23	Hard Flick	None		-	29822
CRC-020816-1	8/16/2002 18:39	Biopsy	MN	OR	JAC	43 48.08	124 25.85	1 of 2	N2	10	NR	JAC 22/24-31		10979	29823
CRC-020816-2	8/16/2002 18:39	Biopsy	MN	OR	JAC	43 47.78	124 26.57	1 of 2	N2	10				PQ	29824
CRC-020821-1A&B	8/21/2002 8:29	Biopsy	BP	CA	JAC	32 43.71	119 15.75	1 of 4	N2	1	NR	JAC 25/15			
CRC-020821-2A&B	8/21/2002 9:54	Biopsy	BP	CA	JAC	32 44.52	119 14.61	1of 2	N2	2	NR	JAC 25/19			
CRC-020821-3A&B	8/21/2002 9:54	Biopsy	BP	CA	JAC	32 44.52	119 14.61	1of 2	N2	2	NR	JAC 25/20			
CRC-020907-1A	9/7/2002 10:12	Biopsy	MN	OR	JAC	44 15.91	124 25.15	1 of 2	N2	5	NR	JAC 30/30		11626	29825
CRC-020907-2	9/7/2002 10:12	Biopsy	MN	OR	JAC	44 15.91	124 25.15	1 of 2	N2	5	Flick	JAC 30/35		11665	29826
CRC-020907-3	9/7/2002 11:23	Biopsy	MN	OR	JAC	44 15.46	124 31.58	1 of 3	N2	7	NR	JAC 31/3		11605	29827
CRC-020907-4A	9/7/2002 11:23	Biopsy	MN	OR	JAC	44 15.46	124 31.58	1 of 3	N2	7		JAC 31/1,7		11643	29828
CRC-020907-5A	9/7/2002 11:52	Biopsy	MN	OR	JAC	44 14.86	124 32.73	1 of 3	N2	8	Flinch	JAC 31/11,12,19		10224	29829
CRC-020907-6A	9/7/2002 11:52	Biopsy	MN	OR	JAC	44 14.86	124 32.73	1 of 3	N2	8		JAC 31/16,20		11590	29830
CRC-020907-7A	9/7/2002 11:52	Biopsy	MN	OR	JAC	44 14.86	124 32.73	1 of 3	N2	8	NR	JAC 31/17-18		11280	29831
CRC-020907-8A	9/7/2002 14:53	Biopsy	MN	OR	JAC	44 26.50	124 50.97	Single	N2	11	Flick	JAC 31/31,37		11118	29832
CRC-020907-9	9/7/2002 16:11	Biopsy	MN	OR	JAC	44 25.66	124 47.53	Single	N2	12	Flick	JAC 31/33-34		11586	29833
CRC-020907-10	9/7/2002 17:27	Biopsy	MN	OR	JAC	44 21.50	124 46.41	Single	N2	14	Flick	JAC 32/2-3		11651	29834
CRC-020916-1	9/16/2002 13:30	Skin from suction cup of	BM	CA	JAC	36 46.85	124 55.66	Trail of 2	N2	5				620	
CRC-020916-2	9/16/2002 13:30	Skin from wires of CC	BM	CA	JAC	36 46.85	124 55.66	Trail of 2	N2	5			Likely same whale as #1	620	
CRC-020918-1	9/18/2002 14:11	Skin from CC	MN	CA	JAC	36 55.69	121 17.21	1 of 3	N2	3		JAC 32B/19		10800	29837
CRC-020918-2	9/18/2002 17:32	Skin from CC	BM	CA	JAC	36 45.68	121 56.38	Single	N2	5				NA	
CRC-020918-3	9/18/2002 17:52	Skin from CC	BM	CA	JAC	36 45.49	121 56.34	Single	N2	6		None		NA	
CRC-020919-1	9/19/2002 9:50	Skin from CC	BM	CA	JAC	36 46.58	121 55.68	Single	N2	3		JAC k64/1 MH 34-36	Likely JAC 32B/23-25	PQ	
CRC-020919-2	9/19/2002 10:31	Skin from CC	BM	CA	JAC	36 45.75	121 55.46	Single	N2	4		JAC 32B/23-25	Likely same as Sample 1	PQ	
CRC-020919-3	9/19/2002 14:22	Skin from CC	BM	CA	JAC	36 44.78	121 57.76	Single	N2	8		JAC 32B/32-33		NA	
CRC-020919-11	9/19/2002 12:05	Biopsy	MN	CA	TEC	38 09.64	123 25.13	3	N1	2	Flick and trumpet blo	TEC 23/14,15		11536	29843
CRC-020919-12	9/19/2002 12:05	Biopsy	MN	CA	TEC	38 09.64	123 25.13	3	N1	2	NR	TEC 23/17		PQ	29844
CRC-020919-13	9/19/2002 13:14	Biopsy	MN	CA	TEC	38 14.67	123 21.36	2	N1	3	Hard Flick	TEC 23/20,32		10801	29845
CRC-020919-14	9/19/2002 16:47	Biopsy	MN	CA	TEC	38 15.18	123 21.61	1 of 2	N1	22	NR	TEC 25/03		11667	29846
CRC-020920-1	9/20/2002 9:18	Skin from CC	BM	CA	JAC	36 45.17	121 57.97	Single	N2	2				NA	
CRC-020921-1	9/21/2002 11:00	Skin from CC	BM	CA	JAC	34 08.27	119 51.50	Trail of 3	N2	7			Calls on tape	NA	
CRC-020921-2	9/21/2002 12:00	Skin from CC	BM	CA	JAC	34 08.46	119 50.19	Single	N2	8				1877	
CRC-020922-1	9/22/2002 14:48	Skin from CC	BM	CA	JAC	34 08.62	119 46.23	Lead of 2	N2	16?			Not sure if correct sighting	NA	
CRC-020924-1	9/24/2002 10:19	Skin from CC	BM	CA	JAC	34 07.96	119 47.95	1	N1	5		JAC 36/23?		PQ	
CRC-020924-10	9/24/2002 11:28	Biopsy	MN	CA	TEC	37 31.49	122 55.81	3	N2	7	Flick	TEC 32/10		10050	29852
CRC-020924-11	9/24/2002 11:53	Biopsy	MN	CA	TEC	37 31.35	122 55.52	2	N2	8	Flick	TEC 32/25		-	29853
CRC-020924-12	9/24/2002 13:20	Biopsy	MN	CA	TEC	37 31.02	122 57.41	3	N2	9	Accelerate	TEC 32/35	Pos. cow	10219?	29854
CRC-020927-1	9/27/2002 15:48	Biopsy	MN	CA	TEC	37 38.37	123 00.51	2	N1	12	Flick	TEC 39/5		PQ	29855
CRC-021007-1	10/7/2002 12:18	Biopsy	MN	CA	TEC	38 01.35	123 24.63	3	N2	6	Flick	TEC 48/24		10956?	29856
CRC-021007-2	10/7/2002 12:18	Biopsy	MN	CA	TEC	38 01.35	123 24.63	3	N2	6	Flick	TEC 48/23		10956?	29857
CRC-021007-3	10/7/2002 12:18	Biopsy	MN	CA	TEC	38 01.35	123 24.63	3	N2	6	Flick	TEC 48/not23,24		10508?	29858
CRC-021008-1	10/8/2002 15:58	Biopsy	MN	CA	TEC	38 39.14	123 33.41	3	N2	4	Flick	TEC 48/31,34		10926	29859
CRC-021013-1	10/13/2002 15:21	Biopsy	MN	CA	TEC	41 57.25	124 30.21	1	N1	7	NR	TEC 50 23-4		10512	29860
CRC-482A&B	8/11/2002	Skin from stranded	BP	Seattle, WA	TEC	47 35	122 20.5						Came in on freighter, so original location uncertain		
CRC-483A&B	9/9/2002 0:00	Skin from stranded	PM	Twin Harbor, WA		46 51	124 07								
CRC-484	10/5/2002	Skin from stranded	BP	Cherry Pt, W	JAC	48 51	122 44						Came in on freighter from Valdez, so original location uncertain		
CRC-485	10/9/2002 0:00	Skin from stranded	PM	Ocean Shore, WA		46 58	124 10								
CRC-021029-1	10/29/2002 9:34	Biopsy	MN	CA	TEC	34 52.77	120 45.12	6	N2	2	Flick	TEC 57/5		10028	29861
CRC-021029-2A&B	10/29/2002 9:34	Biopsy	MN	CA	TEC	34 52.77	120 45.12	6	N2	2	Flick	TEC 57/11		PQ	29862
CRC-021030-1A&B	10/30/2002 11:07	Biopsy	MN	CA	TEC	34 07.42	120 12.20	2	N2	7	NR	TEC 57/31-36?	Not sure if IDed is biopsied wha;e	11664	29863
CRC-021030-2A&B	10/30/2002 16:10	Biopsy	MN	CA	TEC	34 08.07	119 45.87	2	N2	21	Flick	TEC 58/28,30		9029 or 11639	29864
CRC-021031-1	10/31/2002 10:26	Biopsy	MN	CA	TEC	34 08.61	120 15.90	2	N2	21		TEC 59/15,17	small sample	10202	29865
CRC-021031-2A&B	10/31/2002 11:15	Biopsy	MN	CA	TEC	34 07.14	120 04.77	1	N2	9		TEC 59/19-20		10957	29866
CRC-021103-1A&B	11/1/2002 7:45	Biopsy	MN	CA	TEC	32 40.38	119 09.06	3	N2	1	Flick	TEC 61/22		11638	29867
CRC-021103-2	11/3/2002 16:22	Sloughed skin	BM	SCA	TEC	32 36.39	119 05.76	1	N2	Sp-16		TEC 61/31-34	Caller	1781	
CRC-021106-1	11/6/2002 9:23	Biopsy	MN	CA	TEC	34 13.37	120 27.87	2	N2	15	Flick			10409	TO CSB
CRC-021106-2	11/6/2002 9:23	Biopsy	MN	CA	TEC	34 13.37	120 27.87	2	N2	15	Flick			5043	TO CSB
CRC-021106-3	11/6/2002 11:24	Biopsy	MN	CA	TEC	34 12.26	120 32.24	2	N2	17	Flick			10828	TO CSB
CRC-021106-4	11/6/2002 13:30	Biopsy	OO	SBC	TEC	34 08.54	120 37.81	5	N2	17	NR		Juv/fem		
CRC-021106-5	11/6/2002 13:30	Biopsy	OO	SBC	TEC	34 08.54	120 37.81	5	N2	17	NR		Juv/fem		
CRC-021106-6A&B	11/6/2002 13:30	Biopsy	OO	SBC	TEC	34 08.54	120 37.81	5	N2	17	Sink		Ad male		
CRC-486	11/6/2002	Skin from stranded	BP	Skipjack Is, \	JAC	48 45	123 00						Found floating but was a ship strike		

Table 12. Samples obtained from survey in Central British Columbia conduced 1-7 August 2002 in collaboration with Department of Fisheries and Oceans.

Sample #	Species	Date	Time	Snum	Grp	Lat	Long	Reaction	ID photo 1	ID photo 2	Comments
020801-1A&B	MN	1-Aug	11:42	N1-1	2	50 49.00	128 22.83	NR	JAC 16/6	MO 2-11/9-17 (both)	Larger of pair with KW scars
020801-2	PM	1-Aug	15:57	N1-6	1	50 28.06	128 35.56	Tail flinch	JAC 16/23-25		Ad M size measurements with LRF
020802-1	MN	2-Aug	13:12	COT	1	50 41.91	128 57.00	NR	JAC 17/1-2	MO 2-12/9-13	Sm sample
020802-2A&B	MN	2-Aug	15:10	COT-25	2	50 41.71	128 09.73	Tail flinch		MO 2-12/19-20	White fluke
020802-3A&B	MN	2-Aug	15:10	COT-25	2	50 41.71	128 09.73	NR		MO 2-12/21-22	Dark fluke
020802-4	MN	2-Aug	15:50	N1-1	4-5	50 42.58	128 10.39	NR	JAC 17/5-22	MO 2-12/24-31	IDs for whole group
020802-5A&B	MN	2-Aug	17:00	N1-2	2(0?)	50 41.98	128 12.16	NR	JAC 17/23-24	MO 2-12/32-E	Larger of pair
020802-6	MN	2-Aug	17:42	N1-3	2(0?)	50 42.51	128 07.84	Tail flinch	JAC 17/27	MO 2-13/9	Larger whale, sm. sample from edge
020802-7A&B	MN	2-Aug	17:42	N1-3	2(0?)	50 42.51	128 07.84	NR		MO 2-13/7-8	Smaller of pair
020802-8	MN	2-Aug	18:45	N1-4	1	50 41.77	128 10.83	Tail flinch	JAC 17/29		Small sample
020802-9A&B	MN	2-Aug	19:30	N1-5	1	50 42.85	128 14.66	Fluke wave	JAC 17/30-35	MO 2-13/13-17	
020803-1	MN	3-Aug	20:22	COT-52	2(1?)	52 04.59	131 20.16	NR	JAC 18/5-11	MO 2-14/2-	Small sample of cow?
020805-1A&B	MN	5-Aug	10:52	N1-1	1	52 42.98	131 14.61	Tail flinch	JAC 18/14	MO 2-14/20-22	Smallish animal
020805-2A&B	MN	5-Aug	12:15	N1-4	1	52 33.39	131 03.04	NR	JAC 18/15	MO 2-14/24-34	
020805-3	BP	5-Aug	13:50	N1-5	1	52 18.32	131 00.34	NR		MO 2-15/1-9	
020805-4A&B	BP	5-Aug	14:35	N1-6	2	52 15.70	130 59.93	NR	JAC 18/16-18	MO 2-15/11-27	Whale without notch in df
020805-5A&B	BP	5-Aug	14:35	N1-6	2	52 15.70	130 59.93	NR	JAC 18/16-18	MO 2-15/11-27	Whale with notch in df, mostly skin
020806-1A&B	MN	6-Aug	15:03	COT-84	1	50 53.58	129 50.28	Tail flinch	JAC 18/26	MO 5-16/4-8	
020806-2A&B	MN	6-Aug	18:29	N2-2	1	50 51.10	129 40.93	Tail raise	JAC 18/32	MO 2-16/9-20	Big
020806-3	MN	6-Aug	20:19	N2-4	1	50 38.80	129 20.29	Tail raise		MO 2-16/24-25	
020806-4A&B	MN	6-Aug	20:34	N2-5	1	50 39.10	129 19.66	NR			No ID
020807-1	MN	7-Aug	13:13	N2-15	2	51 13.19	127 48.70	NR		MO 2-16/3-6	Larger, only one IDed
020807-2	MN	7-Aug	13:35	N2-16	1	51 14.15	127 48.79	Fluke wave	JAC 20/12	MO 2-16/7-8	
020807-3	MN	7-Aug	13:50	N2-17	2	51 14.68	127 48.33	NR		MO 2-196/10,14,15	Larger
020807-4	MN	7-Aug	13:50	N2-17	2	51 14.68	127 48.33	NR		MO 2-16/13	Smaller of pair
020807-5	MN	7-Aug	16:40	N2-29	2	50 53.65	127 36.10	NR	JAC 21/25		small sample
020807-6A&B	MN	7-Aug	16:40	N2-29	2	50 53.65	127 36.10	NR	JAC 21/26-27		

Table 13. Number of unique blue whales identified by Cascadia and collaborators by year and region for California through 2002.

		Number of individuals identified																	
REGION	**Code**	**>86**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**All**
S Ca. Bight (south)	31	1	0	0	0	0	5	17	0	7	1	33	16	11	43	0	9	19	6	161
S. Ca. Bight (north outside SB(	32	2	2	0	0	0	0	1	19	5	34	90	9	22	0	0	0	162	44	339
Santa Barbara Channel	33	0	0	0	0	0	0	0	106	0	144	102	77	102	77	120	16	9	176	656
S. California (offshore)	39	3	1	0	0	0	0	20	0	32	0	0	8	0	0	0	0	0	2	66
Pt Concpetion to Buchon	41	0	0	0	0	0	0	4	0	2	6	5	2	8	0	0	18	6	39	88
Pt Buchon to Pt. Sur	42	0	0	0	0	0	0	0	0	2	0	0	7	0	0	6	3	9	0	27
S Monterey Bay Sanc.	51	9	42	61	25	15	0	0	6	18	18	8	21	10	84	16	95	41	32	398
N Monterey Bay Sanc.	52	0	0	0	0	0	2	0	1	45	0	3	4	4	1	5	0	19	4	86
Farallones/Cordell	53	9	36	74	95	64	102	27	109	25	29	7	26	40	22	42	46	21	36	442
Bodega Bay to Pt. Arena	54	0	0	0	17	1	0	0	20	0	1	0	4	5	0	3	0	0	6	51
C. California offshore	59	0	0	0	0	0	0	3	0	9	0	0	2	0	0	0	0	0	0	14
Pt. Arena to C. Mendocino	61	0	0	0	0	0	0	2	92	0	0	0	0	4	7	0	0	2	1	105
C Mend. to Klamath Riv.	62	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4
N California to Oregon	63	0	0	0	0	0	0	4	4	0	0	0	0	0	7	0	0	2	0	17
Oregon	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
All		24	79	128	122	77	109	76	279	126	208	229	168	181	226	176	170	275	312	1495

Table 14. Number of unique humpback whales identified by Cascadia and collaborators by year and region for California, Oregon and Washington through 2002.

		Number of individuals identified																		
REGION	**Code**	**>86**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**All**
S Ca. Bight (south)	31	0	0	0	0	0	0	1	0	5	3	0	0	4	0	0	0	0	3	15
S. Ca. Bight (north outside SBC)	32	0	0	0	1	0	1	0	3	1	6	18	0	0	5	0	0	4	1	38
Santa Barbara Channel	33	0	0	0	4	0	6	15	97	9	13	136	22	27	101	18	1	3	72	289
S. Califonria (offshore)	39	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4
Pt Concpetion to Buchon	41	0	0	8	58	0	0	78	4	1	14	20	0	23	3	2	69	13	33	229
Pt Buchon to Pt. Sur	42	0	0	0	2	0	2	12	0	0	0	0	8	13	16	9	5	4	0	69
S Monterey Bay Sanc.	51	3	0	4	15	2	13	13	65	45	59	33	89	92	145	175	144	71	40	565
N Monterey Bay Sanc.	52	0	0	0	2	0	20	0	0	26	4	42	82	47	30	12	0	115	31	332
Farallones/Cordell	53	16	90	140	133	110	161	89	172	181	164	127	168	34	89	116	33	82	110	798
Bodega Bay to Pt. Arena	54	0	1	0	5	0	0	0	63	6	0	0	4	5	22	2	0	0	0	104
C. California offshore	59	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	4
Pt. Arena to C. Mendocino	61	0	0	0	0	0	0	4	73	2	0	0	0	23	22	0	0	0	20	138
C Mend. to Klamath Riv.	62	1	0	0	8	0	0	4	0	4	0	12	8	26	6	0	0	0	0	61
N California to Oregon	63	0	0	0	3	0	0	85	50	16	0	1	0	14	69	6	0	3	9	193
S Oregon	71	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	5	2	9
C. Oregon	72	0	0	0	0	0	22	0	0	0	0	0	7	0	0	30	9	2	30	92
N Oregon	73	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	1	0	7
Washington	75	0	0	0	0	0	5	0	0	0	0	0	0	0	1	0	0	6	0	12
Wash/BC border	76	0	0	0	1	1	10	13	0	3	16	35	34	22	47	60	31	35	32	179
Puget Sound	79	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
All		20	91	150	213	111	218	282	398	257	260	365	366	289	435	388	261	310	347	1438

Table 15. Reproductive rates of humpback whales off California based on photo-identification. Total m/c (mothers or calves) is the highest number of mothers or calves identified (including tentative identifications). The total number of whales identified includes mothers and calves. See Steiger and Calambokidis (2000) for analysis of 1986-96.

	# of mothers IDed		# of calves IDed		Total identified		
Year	**definite**	**tentative**	**definite**	**tentative**	**m/c**	**all**	**Rate**
86	1	0	1	0	1	88	1.1%
87	3	1	3	1	4	143	2.8%
88	7	1	3	1	8	170	4.7%
89	1	0	3	0	3	62	4.8%
90	3	1	2	0	4	126	3.2%
91	8	3	5	3	11	225	4.9%
92	8	3	2	2	11	350	3.1%
93	10	1	9	2	11	214	5.1%
94	5	0	5	0	5	205	2.4%
95	17	8	15	4	25	314	8.0%
96	10	6	7	3	16	306	5.2%
97	15	1	4	2	16	265	6.0%
98	18	2	6	2	20	389	5.1%
99	13	5	7	2	18	348	5.2%
00	10	0	5	0	10	230	4.3%
01	11	6	6	4	17	276	6.2%
02	12	1	6	0	13	317	4.1%

*number of calves used instead of mothers in 1989 because it is higher

Table 16. Humpback whale abundance off California, Oregon, and Washington using Petersen mark-recapture estimates with annual samples. Coefficients of variation (CV1 and CV2) are based on analytical formulae and jackknife (respectively).

	Sample 1				Sample 2							
Period	**Year**	**Subs.**	**Ident.**	**n**	**Year**	**Subs.**	**Ident.**	**n**	**Match**	**Est.**	**CV1**	**CV2**
Annual samples using all data												
1991-92	1991	7	668	269	1992	8	1,023	398	188	**569**	0.03	0.05
1992-93	1992	8	1,023	398	1993	6	512	254	173	**584**	0.03	0.06
1993-94	1993	6	512	254	1994	6	402	244	108	**572**	0.05	0.15
1994-95	1994	6	402	244	1995	9	662	331	100	**804**	0.06	0.17
1995-96	1995	9	662	331	1996	7	565	332	145	**756**	0.05	0.08
1996-97	1996	7	565	332	1997	7	385	267	105	**841**	0.06	0.16
1997-98	1997	7	385	267	1998	8	854	388	119	**868**	0.06	0.13
1998-99	1998	8	854	388	1999	6	613	331	126	**1,016**	0.06	0.10
1999-2000	1999	6	613	331	2000	8	615	230	107	**709**	0.06	0.17
2000-01	2000	8	615	230	2001	8	488	274	81	**774**	0.07	0.16
2001-02	2001	8	488	274	2002	8	488	315	83	**1,034**	0.08	0.11
Annual samples using only re-evaluated sample of "catalog quality" photographs												
1994-95	1994			210	1995			285	76	**783**	0.08	
1995-96	1995			285	1996			256	91	**798**	0.07	
1996-97	1996			256	1997			203	69	**748**	0.08	
1997-98	1997			203	1998			327	75	**879**	0.08	
1998-99	1998			327	1999			258	80	**1,048**	0.08	
1999-2000	1999			258	2000			193	69	**717**	0.08	
2000-01	2000			193	2001			245	63	**745**	0.09	
2001-02	2001			245	2002			242	58	**1,012**	0.10	
Annual samples excluding Oregon and S Washington												
1991-92	1991	7	668	269	1992	8	1,007	394	187	**566**	0.03	0.052
1992-93	1992	8	1,007	394	1993	6	512	254	173	**578**	0.03	0.053
1993-94	1993	6	512	254	1994	6	402	244	108	**572**	0.05	0.148
1994-95	1994	6	402	244	1995	9	662	331	100	**804**	0.06	0.166
1995-96	1995	9	662	331	1996	7	558	325	144	**745**	0.05	0.081
1996-97	1996	7	558	325	1997	7	385	267	105	**823**	0.06	0.157
1997-98	1997	7	385	267	1998	8	853	387	119	**866**	0.06	0.127
1998-99	1998	8	853	387	1999	6	564	302	120	**971**	0.06	0.129
1999-2000	1999	6	564	302	2000	8	606	221	104	**640**	0.06	0.155
2000-01	2000	8	606	221	2001	8	474	261	81	**708**	0.07	0.148
2001-02	2001	8	474	261	2002	8	452	285	80	**924**	0.08	0.09

n-Number of unique individuals in sample used in mark-recapture estimate

Est.-Estimated abundance

CV1-Coeficient of variation based on Chapman

CV2-Alternate estimate of coefficient of variation using Jackknife proceedure (see Methods)

Table 17. Model parameters and population estimates from Jolly-Seber mark-recapture method using California, Oregon, and Washington (not incl. WA/BC border) for 1991-2001.

Year	**IDs**	**Prev IDs**	**r**	**z**	**Surv**	**Births**	**Marked available**	**Popul. estimate**	**SE**
1991	269	0	253	0	0.97				
1992	398	188	359	65	0.97	49	260	549	17
1993	254	199	224	225	0.95	84	454	579	18
1994	244	186	215	263	0.97	147	484	635	22
1995	331	228	277	250	0.99	61	527	763	26
1996	332	253	246	274	0.89	41	622	816	29
1997	267	217	200	303	0.96	116	621	763	29
1998	388	294	232	209	0.8	158	643	848	33
1999	331	233	193	208	0.85	-11	589	836	40
2000	230	192	122	209	1.05	212	585	700	40
2001	274	189	83	142			654	946	84
2002	315	225							
Mean	302	198	219	195	0.94	95	544	744	
SD	58	74	73	92	0.07	69	120	127	

Table 18. Summary of Petersen mark-recapture estimates for blue whales off California and W. Baja Mexico.Sample n1 is the number of unique identified whales from SWFSC systematic ship surveys and n2 is from coastal small-boat work. The number of matches or recaptures (m) are indicated. Coefficients of variation (CV) are based on analytical formulae.

Samples used	**Left sides**					**Right sides**					**Mean**
	n1	**n2**	**m**	**Est.**	**CV1**	**n1**	**n2**	**m**	**Est.**	**CV1**	
Pooled years using survey type as samples											
1991-93 all qualities	61	293	8	**2,024**	0.29	74	289	10	**1,976**	0.26	**2,000**
1995-97 all qualities	43	350	7	**1,930**	0.30	34	361	7	**1,583**	0.29	**1,756**
2000-2002 all qualities	20	447	5	**1,567**	0.32	24	468	5	**1,953**	0.33	**1,760**

Table 19. Success rate in approaching and attaching tags to whales.

	Appr.	Contact		Attach		Recov/funct.	
		#	%	#	%	#	%
Blue whales							
Bodega 1999	>15	7	<50%	1	<10%	1	<10%
Monterey 2000	6	3	50%	1	17%	1	17%
Baja 2001	16	7	44%	5	31%	4	25%
S California 2001	26	18	69%	12	46%	11	42%
S and C California 2002	46	27	59%	25	54%	23	50%
Total	109	62	57%	44	40%	40	37%
Humpback whales							
S Cal 2002	12	3	25%	2	17%	2	17%

Table 20. Summary of tag deployments in 2002.

Deploy				Deployment		Detach	Hours	Detach	Recovery						Type of								
Date/time	Tag	Sp	Region	Latitude	Longitde	Time	on	reason	Time	Latitude	Longitde	Num	SN#	Beh	deployment	Track data	Dive	Photos	IDs	Skin	Sex	Reaction	Comments
6/19/2002 11:06	Burges s	Mn	SBC	34 18.77	119 51.43	11:25	0.3	Front gummy gone only rear held suction	11:25	34 20.25	119 51.87	2	8	Mill	Put tag on whale	Mostly complete	Yes	JAC 1/24-5	10597	None		Tail slap	Tag slid back on one cup, acoustic saturation (vibration of front cup?)
6/22/2002 10:45	dTag	Mn	SBC	34 12.65	119 50.82	10:48	0.0	Failure of front cup to seal	10:52	34 12.71	119 50.79	1	11	Travel	Attach tag	Short	Yes	JAC 3/3-7	PQ	None		NR	Out-bound freighter approaching
6/23/2002 11:19	dTag	BM	SBC	34 08.01	119 53.21	12:29	1.2	Detached early	12:30	34 06.52	119 48.59	2	8	Travel	Put tag on trail whale	Good incl. post-tag	Good	JAC 3/21-E	370	020623-1 from robot head	M	Pos. early termination of SS	Trail does not surface next series, appears to be normal pattern, Caller
6/24/2002 12:34	dTag	BM	SBC	34 08.34	119 56.11	19:51	7.3	Unclear why no release, wire burned but set for 2h	15:00	34 15.82	120 12.42	1	1	Mill - travel	Put tag on single	Ex intil 1900	Good	JAC 4/1-17 Col/1-10	951	020624-1 robot 020625-1 tag	F	Pos. sink and early term. of SS	Tag recovered the next dat
6/25/2002 18:02	Burges s	Bm	SBC	34 06.98	120 10.21	18:05	0.0	Put on backwards	18:08	34 06.97	120 10.07	1	3	mill	Tag put on whale	Too short	Dive to 20 m	None		None		Sink, term. SS	Out of position (1 engine) tag put on backward
6/26/2002 7:58	Burges s	BM	SBC	34 07.42	120 00.36	8:02	0.1	Rear gummy was gone (blown out on tagging?)	8:07	34 07.48	120 00.57	2	2	Mill	Put tag on trail of pair	Too short	Single dive to 60m	None		None		Sink, accel., term. SS	Used flex head, may not have gotten solid press on, gummies good
6/26/2002 9:03	Burges s	BM	SBC	34 06.85	120 04.25	11:54	2.8	Tag slid while on, gummies & suction good on recovery	12:00	34 06.65	120 04.79	1	4	Mill, travel	Put tag on single	Till 10:20 then lost, more from	8 dive seiries to about 165m	JAC 5/1,3-6, col 11-2	1864	020626-2 (sm. Sk from cup)		Accel., extends SS dive	Solid attachment, 2nd appr on SS stayed with animal below surface
6/27/2002 7:27	Burges s	BM	SBC	34 06.64	120 05.53	7:39	0.2	Good atchmt. rear gummy blew out	7:41	34 06.68	120 05.61	1	2	Mill	Put tag on single	Short	One dive series to 120 m	JAC 7/16	1852	020627-1		Suspend SS, back flex	Lead gummy out, USGS ship appr.
6/27/2002 10:22	Burges s	BM	SBC	34 06.84	120 03.84	10:24	0.0	Attached underwater, no good attmt.	10:25	34 06.83	120 03..84	1	11	Mill	Brief attach to single	Too short	Comes off on 1st dive	None		None		Sink	
6/27/2002 10:49	Burges s	BM	SBC	34 06.92	120 03.17	12:18	1.5	Gummies intact	12:21	34 06.59	120 06.02	1	13	Mill	Put tag on single	None	7 feeding dive series to 160m	JAC 7/18-21	PQ	None		Interupt SS then resume	
6/30/2002 12:19	Burges s	BM	SC	32 38.02	117 26.96	14:30	2.2	Gummies intact	14:31	32 40.61	117 25.36	1	201	Travel	Put tag on single	Partial	Tag reset, caller?	JAC 10/1-3	445	020630-1&2	F	Interupt SS then resume	Sample 1 from biopsy,2 from tag. Tag fails, no data
6/30/2002 15:49	Burges s	BM	SC	32 47.10	117 22.63	next day	25-39	Detach 1700-0700, 15 h data, Gummies intact	7/2	32 49.06	117 20.68	1	202	Travel-mill	Put tag on trail of pair	Good for 12h	Excelent	JAC 10/6-25	336	020630-4	M	Terminate SS	Both whales biopsied
9/16/2002 12:14	CC	BM	Monter ey	36 46.59	121 57.02	13:20	1.1	Unknown	13:30	36 46.85	119 55.66	2	5	Mill-travel	Tag trail of pair	Good for 1st half, lost	Yes	JAC 32/2-4	620	020916-1(cup) 020916-2(head)	M	Sink	Stapp may have IDs also
9/18/2002 17:21	CC	BM	Monter ey	36 45.58	121 56.43	17:26	0.1	Unknown	17:32	36 45.68	121 56.38	1	5	none	CC on single animal	A few surfacings	Yes	None		020918-02	M	Sink, terminate SS	
9/18/2002 17:52	CC	BM	Monter ey	36 45.49	121 56.34	17:56	0.1	squib released tag came off, not sure other than lots of skin	17:56	36 45.49	121 56.34	2	6		CC on single animal		Yes	None		020918-03		Terminate, SS	Difficulty detaching pole/head from CC. Had to leverage against boat
9/19/2002 9:50	CC	BM	Monter ey	36 46.58	121 55.58	10:01	0.2	attach tag to left side	10:06	36 46.58	121 55.59	1	3	Mill	VHF tag	Good	Yes	SL/1	PQ	020919-1	M		Tag shift to right side, S#4 may be same whale
9/19/2002 10:31	CC	BM	Monter ey	36 45.75	121 55.46	10:32	0.0	Unknown	10:33	36 45.70	121 55.46	1	4	Mill	CC on single animal		Yes	JAC32B/23-5,SL/2-4	PQ	020919-2	M	Acceleration	Camera floating in wake of whale
9/19/2002 14:22	CC	BM	Monter ey	36 44.78	121 57.76	14:22	0.0	Unknown	14:24	36 44.81	121 57.69	1	8	Mill	CC on single animal		Yes	JAC 32B/32/33	PQ	020919-3		No reaction	lots of skin in water, not sure why CC fell off
9/20/2002 9:18	CC and Burges	BM	Monter ey	36 45.17	121 57.89	9:21	0.0	Unknown	9:21	36 45.19	121 57.97	1	2		Attach CC & Burgess tag		Yes			020920-1			Both tags came off
9/21/2002 11:00	CC	BM	SBC	34 08.27	119 51.50	11:25	0.4	vacuem released through squib	11:25	34 08.00	119 51.11	3	7		Attach CC & Burgess tag on	Good	Yes	JAC 33/1-8	PQ	020921-1	M	Sink	Recorded "A" call 'Steady CC beeps, Burgess on no beeps (malfunction)
9/21/2002 11:00	Burges s	BM	SBC	34 08.27	119 51.50	13:50	2.8	vacuum released through squib	9:18	34 06.61	119 39.63	3	7		Attach CC & Burgess tag on	Good	No, tag not working	JAC 33/1-8	PQ	020921-1	M	Sink	Recorded "A" call 'Steady CC beeps, Burgess on no beeps (malfunction)
9/22/2002 12:50	CC	BM	SBC	34 08.61	119 46.89	12:55	0.1	Leaking around squib, fill with nut and bolt	12:57	34 8.39	119 46.94	2	12		Brief attach to L side of trail of	None	Yes	None		None		inturrupt SS	Place CC on R of trail, chopped dorsal fin, CC cup is leaking
9/22/2002 14:48	CC	BM	SBC	34 08.62	119 46.23	14:49	0.0	Trouble with pole	14:49	34 08.62	119 46.23	2	16		Attach briefly to lead animal	Too short	Yes	None		None		Sink, interrupted SS, resume	Large lead whale, trouble disengaging from pole
9/23/2002 10:26	CC	BM	SBC	34 09.16	119 47.31	10:26	0.0	Close approach and attachment low on left	11:20	34 09.31	119 46.94	2	5B		Attach low on L of trail of pair	Good	Yes	JAC 34/27-:	760	None		Suspend then resume,	Recover CC, no VHS signal
9/24/2002 10:18	CC	BM	SBC	34 07.96	119 47.95	10:19	0.0	Unknown	10:19	34 07.96	119 47.95	1	5	Mill	Attach CC to small animal	Too short	Yes			020924-1		Accelerate Terminate SS	
9/24/2002 12:01	CC	BM	SBC	34 07.81	119 46.37	12:18	0.3	Unknown	12:18	34 07.89	119 46.21	1	10	Mill	Briefly attach to single	Too short	Yes	JAC36/34-E, 37/1-6	PQ	None			Camera on and off

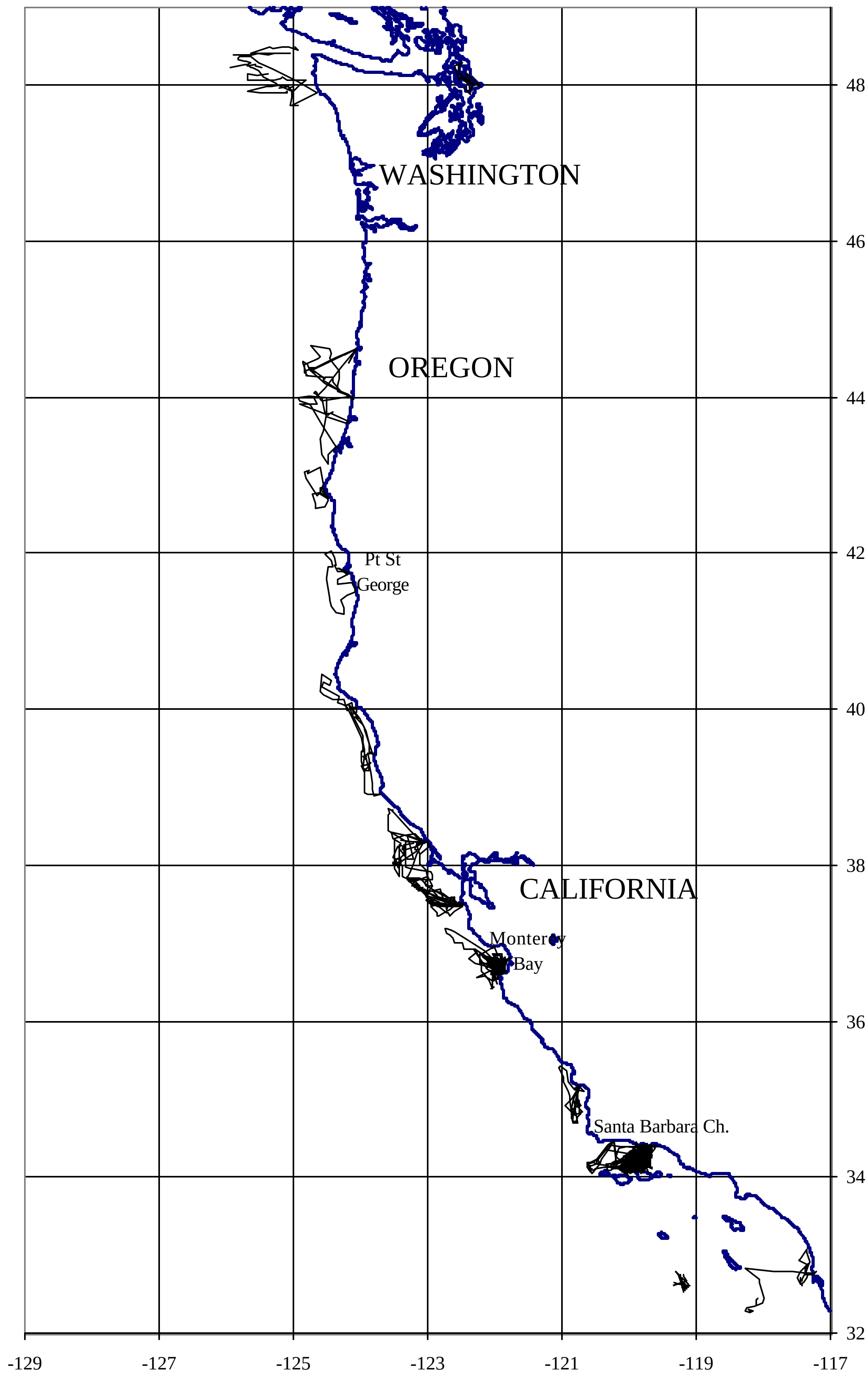

Figure 1. Photo-ID survey effort along the coast of California, Oregon, Washington in 2002

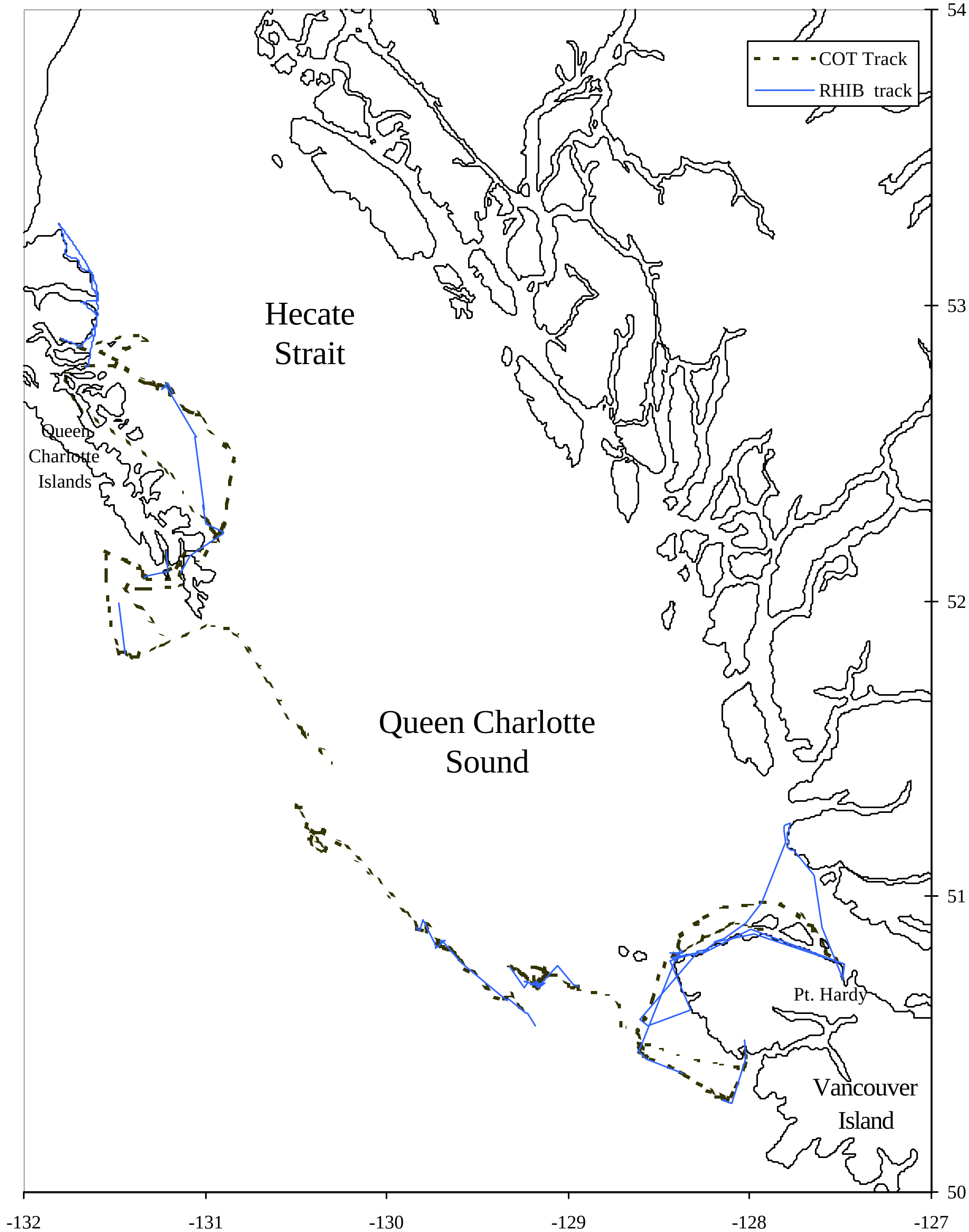

Figure 2. Survey effort during cruise off Central British Columbia, 31 July to 7 August 2002.

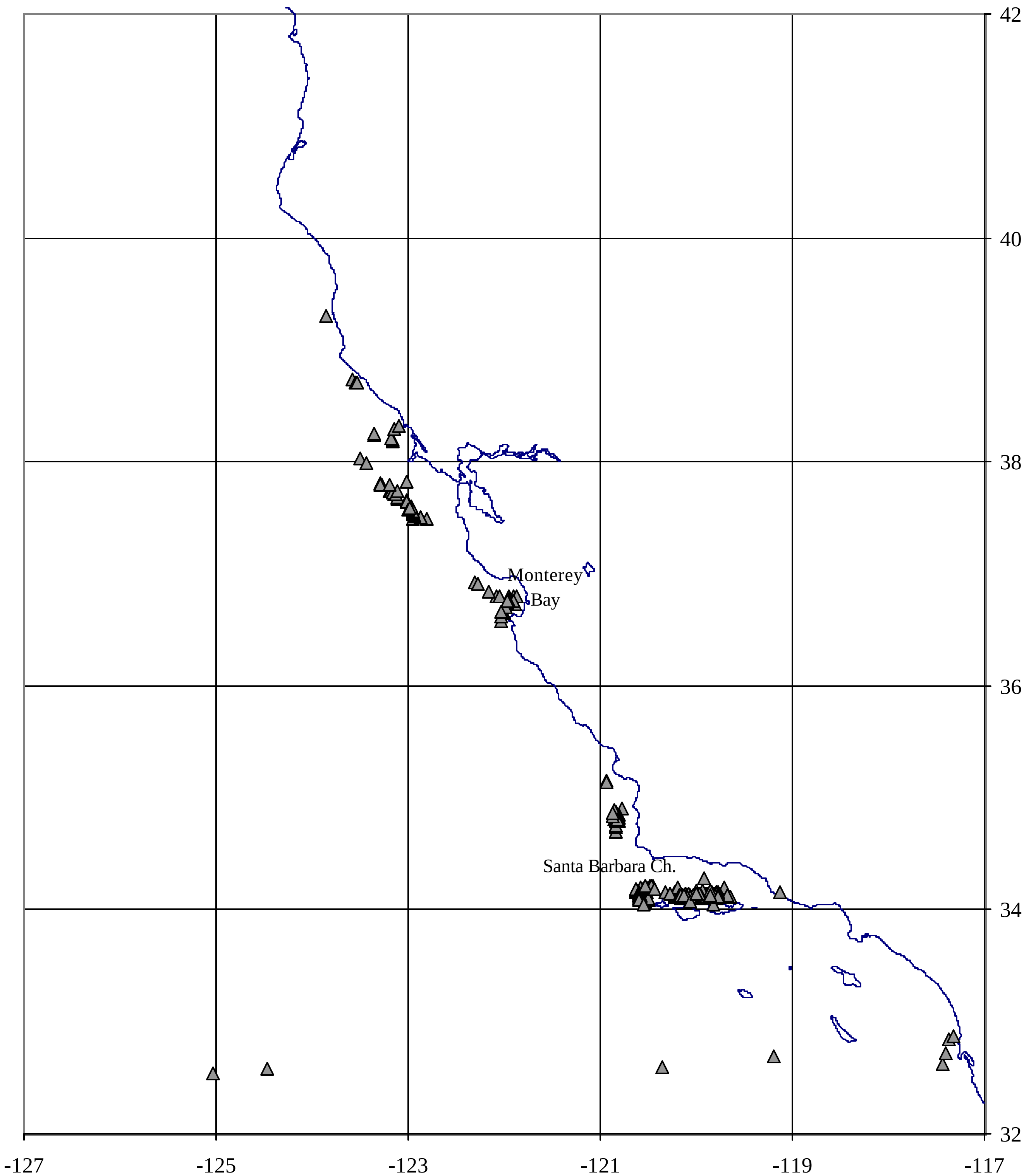

Figure 3. Locations of blue whale identifications off California in 2002.

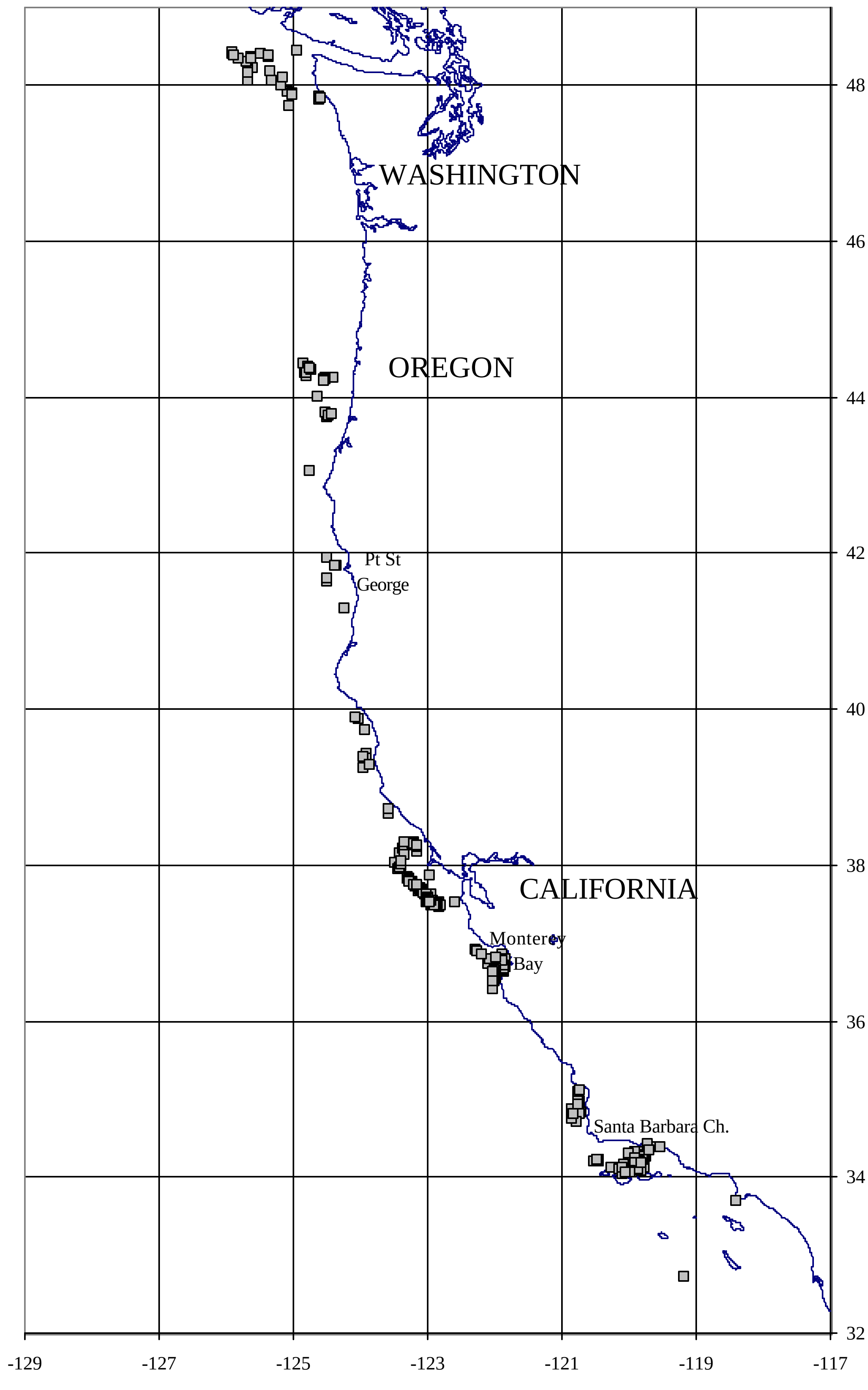

Figure 4. Locations of humpback whale identifications off California, Oregon, and Washington in 2002.

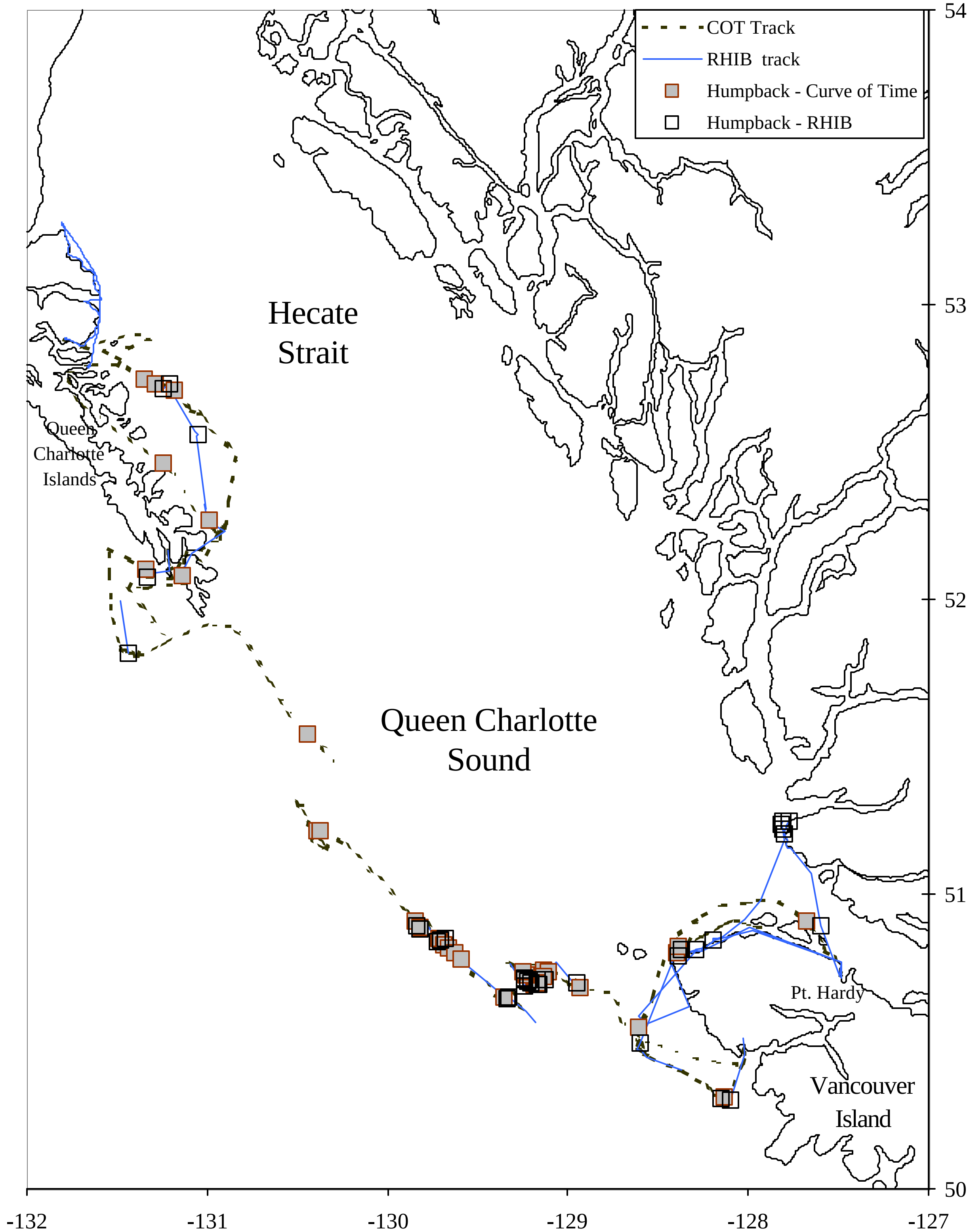

Figure 5. Location of humpback whales seen during surveys off Central British Columbia from 31 July to 7 August 2002.

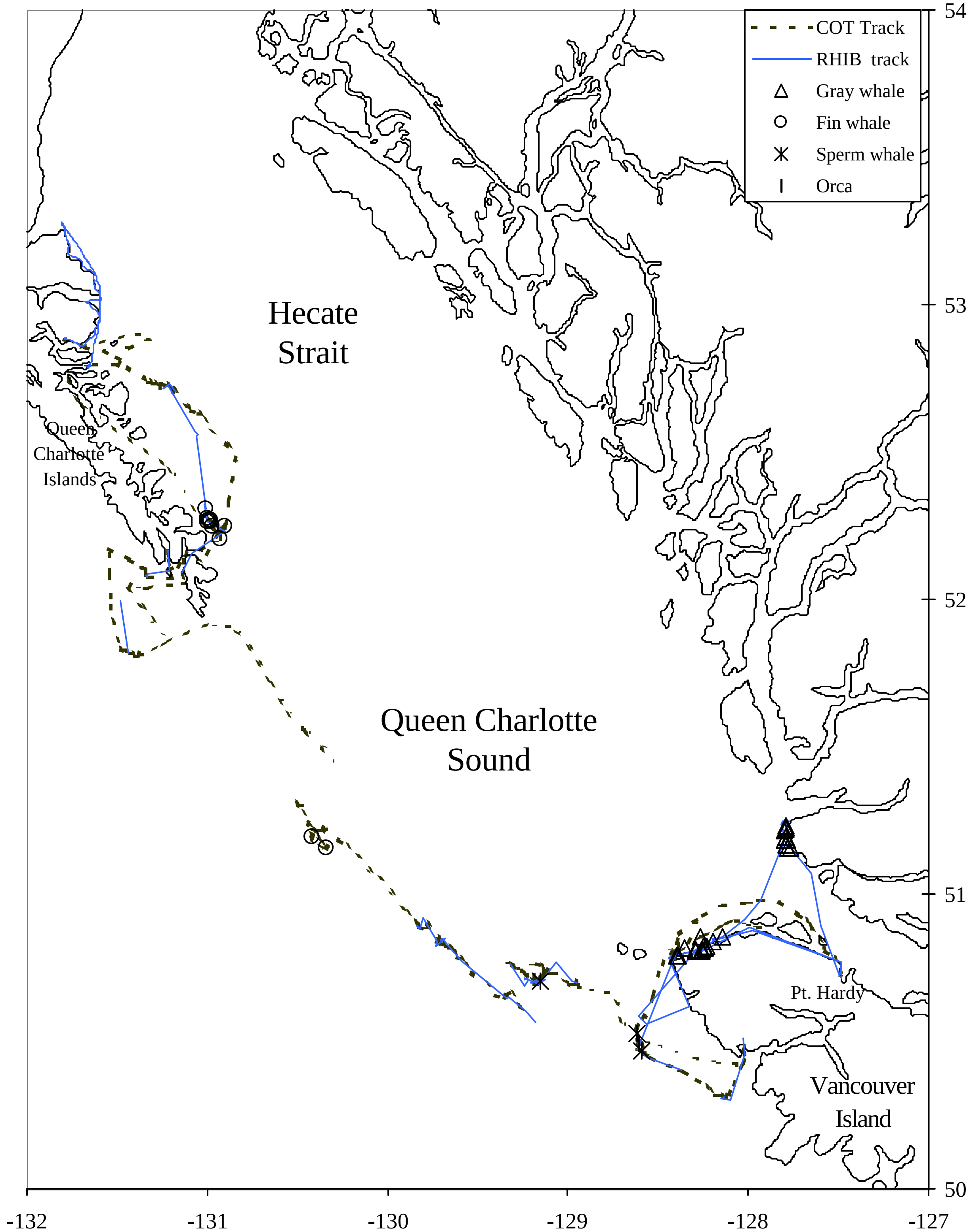

Figure 6. Locations of sightings of other whales during central BC survey, 31 July to 7 August 2002.

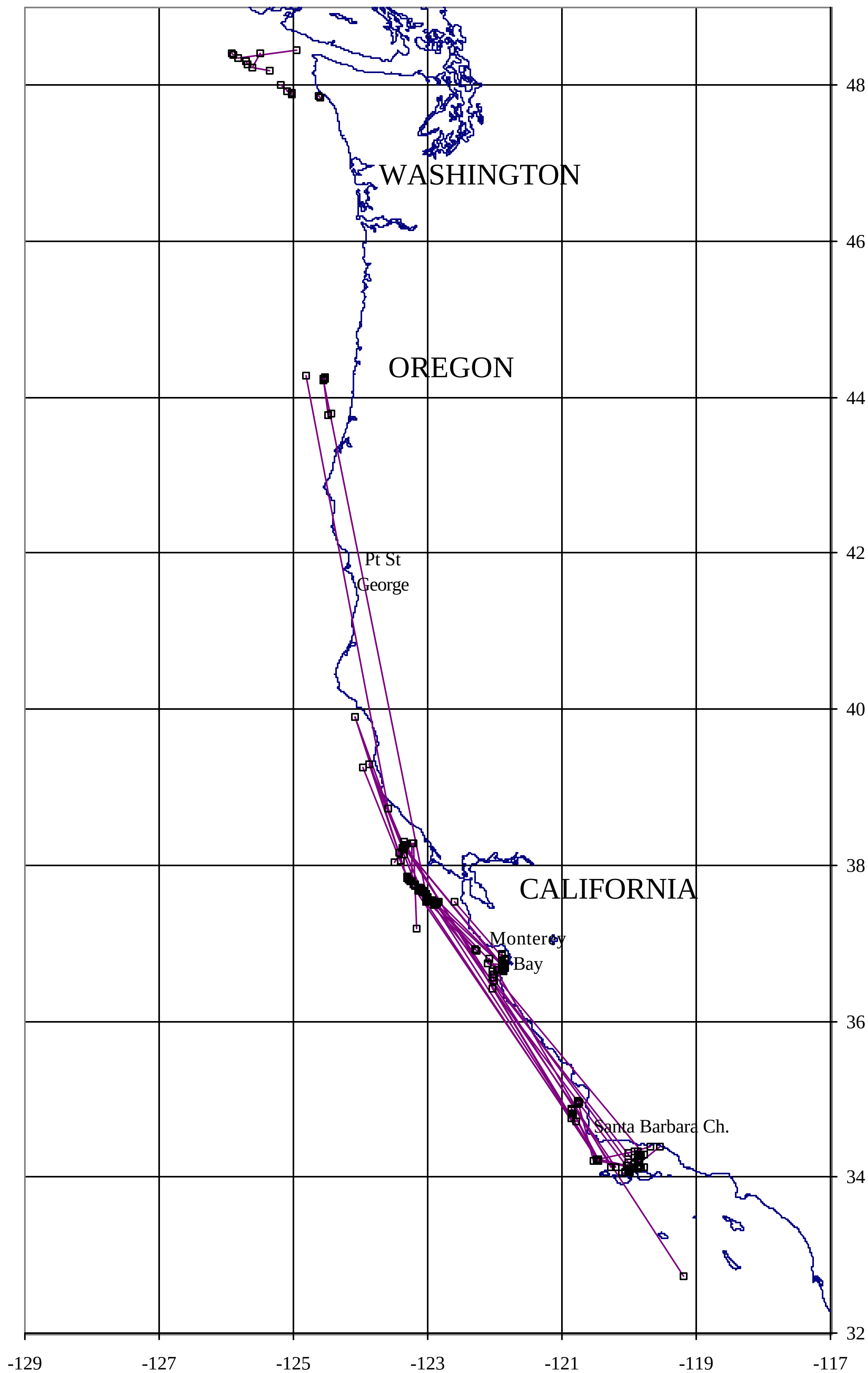

Figure 7. Movements of identified humpback whales off California, Oregon, and Washington in 2002.

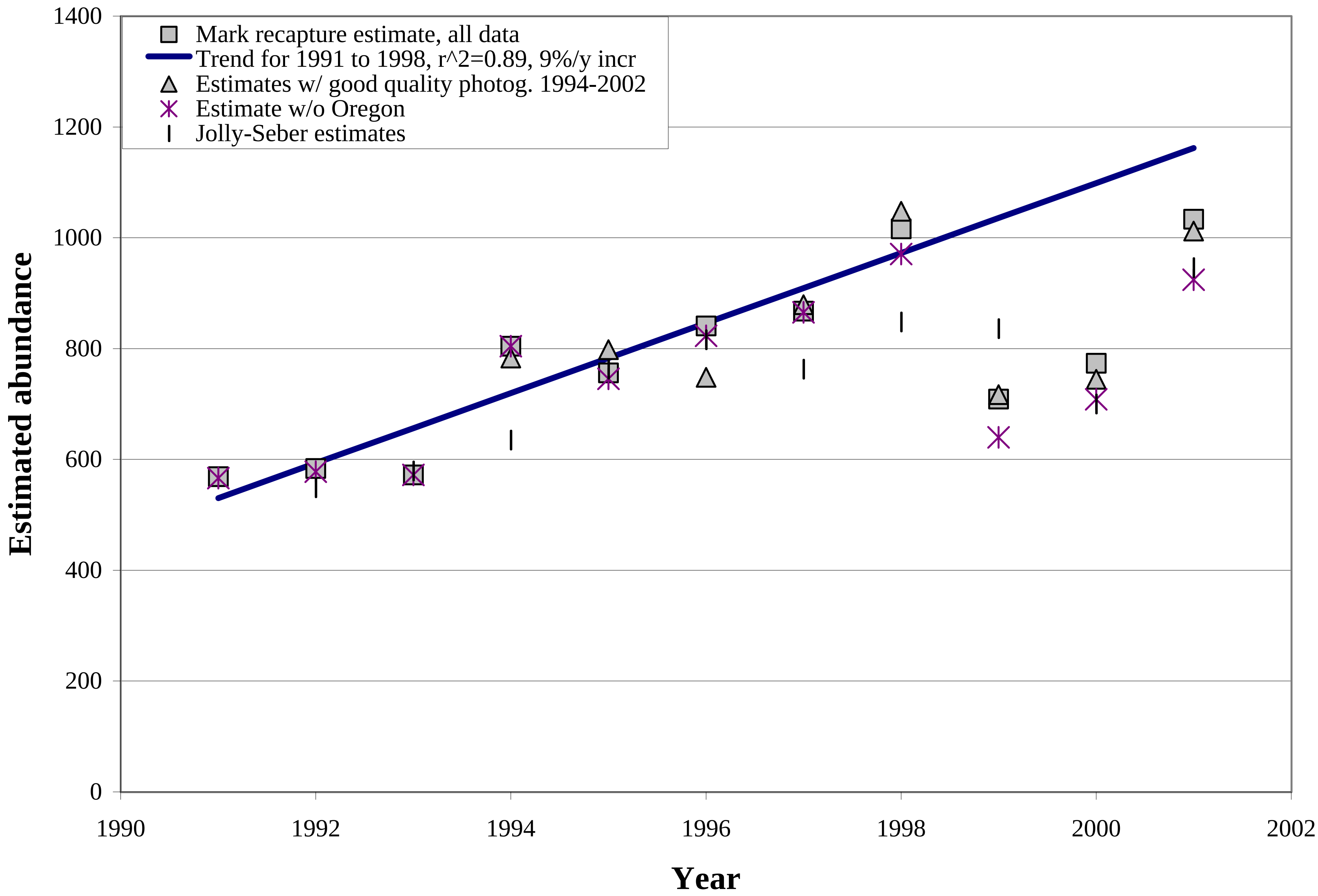

Figure 8. Estimates of humpback whale abundance off California by year using different models.

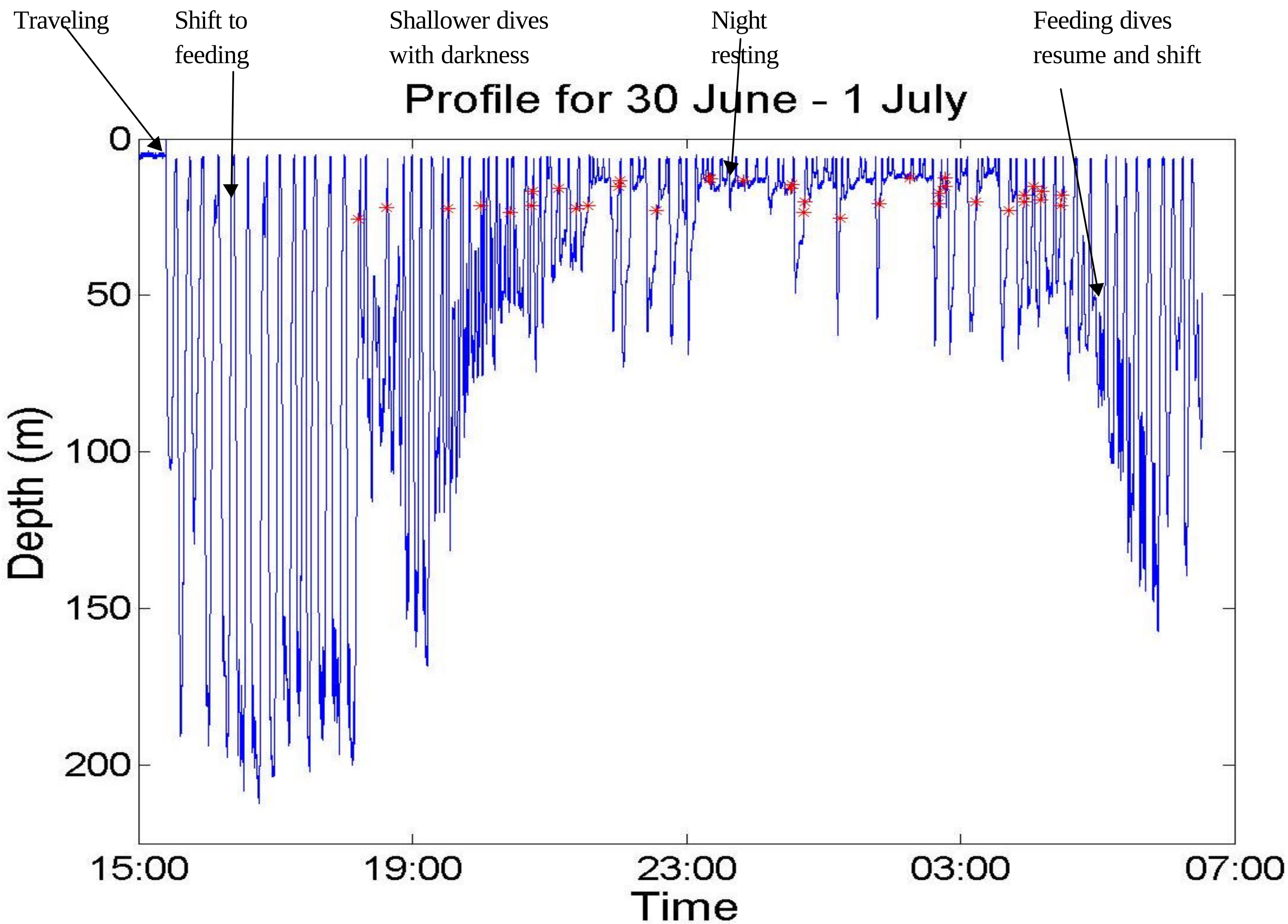

Figure 9. Dive behavior of blue whale tagged with Burgess Bio-probe on 30 June 2002 off San Diego. * show locations of vocalizations.